INDUSTRIAL ENGINEERING

PLANT ENGINEERING IN INDUSTRY

A McGraw-Hill Publication—Founded 1882

Volume 87 CHICAGO, DECEMBER, 1929 *Number 12*

It doesn't cost any more to sit at the table—

. . . Something has established our devotion to the lunch counter. Perhaps railroad stations are responsible—maybe it's just our always being in a hurry—or possibly we feel that the prices are lower.

. . . Most of which is by way of being in error. In the average eating place it doesn't cost any more to sit at the table. We get the same menu and we hand out the same tips, so we may just as well have the cloth, the effect of leisure, the feeling of well-being that go with the table.

. . . Chances are that the man with a lunch counter complex will have his work at the plant thought out for him by somebody else. And that's bad. It's even worse than it looks, because in reality he should have a voice in the plant planning—especially when he is a member of the plant engineering group.

. . . Taking for granted what finds its way into the plant; failing to find out what can be done in the way of preventive maintenance; remaining ignorant or silent concerning advanced practice in power transmission, materials handling, lighting, heating, safety, and the other essentials of plant engineering—that's eating at the lunch counter.

. . . Keeping abreast of the times by reading, by discussing, by plant visiting; planning for inspection, replacement, and modernization; getting across the truth concerning these matters within your own organization—that's sitting at the table.

. . . And the means for doing so are available. Your industrial publication is a part of them; plant engineers' club and other organizations afford opportunities for discussion; plant visitation is becoming a recognized industrial tool; the whole industrial world is rapidly becoming modernization-minded.

. . . Pushing past the lunch counter a few times—persistent reading, planning, and discussing—will demonstrate that it doesn't cost any more to sit at the table either to eat food, or in the industrial sense, and that there are tangible advantages to so sitting.

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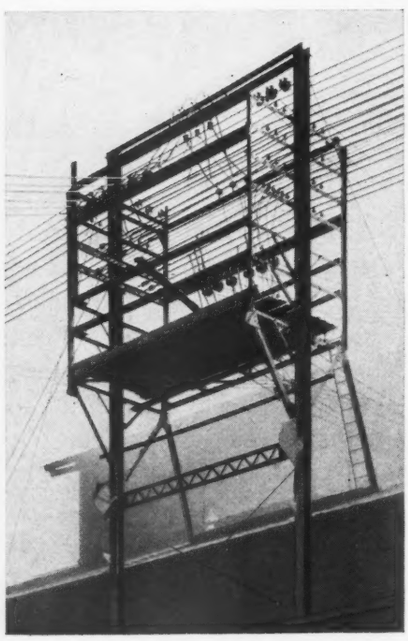
Distributing

How it is done at the Canton Plant of

As told to
W. A. BECK
Managing Editor, Industrial Engineering

POWER distribution systems are interesting in direct proportion to the difficulties of the problems overcome or, in other words, according to the amount of ingenuity required to develop them. In the case of the Canton plant of The Timken Roller Bearing Company, the problems were difficult beyond the ordinary, being made so by the character of the load. Nevertheless, a system of distribution has been worked out which, if not simple in the strict sense of the term, is decidedly simple considered in connection with the results to be accomplished. And, which is the final test, it is thoroughly effective. The complexity of the problems encountered is the result of a combination of circumstances, which have created a situation rather unusual in industrial plants.



Main distributing point for 2,300-volt feeders. All lines from the substation come to this tower whence they are carried to the individual transformer stations located at the various load centers.

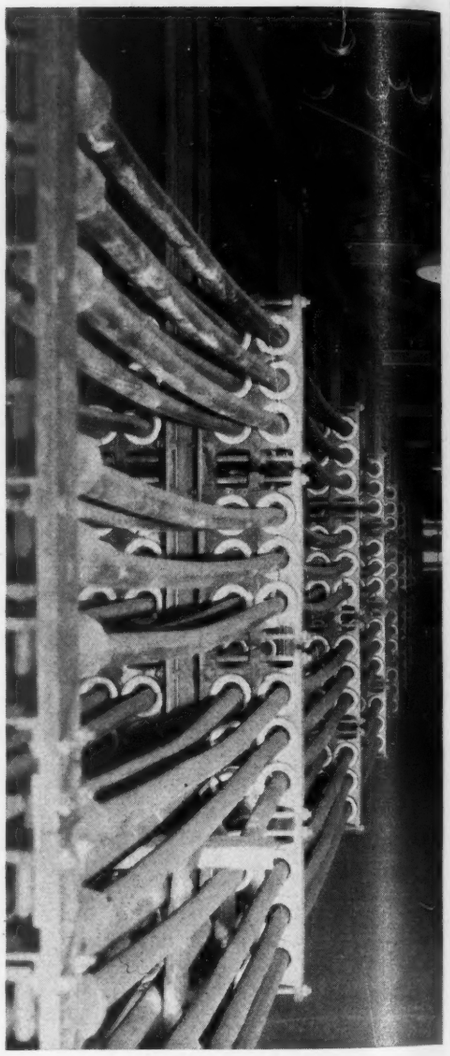
In most cases an industrial plant load is confined to one, or at most two, types of power demand. In this particular case there are four distinct loads with individual characteristics and requirements. The problem resolves itself into one of devising the most economical and effective method of supplying these loads from a single source.

Before discussing the methods actually adopted, a more detailed description of the existing situation will be made. The first complication arises from the fact that the plant is really two plants, a steel mill and a bearing factory. As far as load requirements are concerned, the two have nothing in common. Those of the former are unusually difficult, even in steel mill practice, and those of the latter comparable to almost any conventional factory load.

The steel mill situation is involved principally by a large electric-furnace load, with characteristically poor load and power factors, and by the fact that both a.c. and d.c. motors are extensively used both for main and auxiliary drives.

There is also a question of power and load factor to be settled. Also, it has been difficult to establish well defined load centers in the mill, partly because of the diversity of the load, and partly because of certain physical factors such as the location of the equipment and its general arrangement. In fact each one, the mill and the factory, present a different set of requirements, as distinct as those of two separate industrial plants. How they have been settled as a single problem is one of the interesting features of the system.

Power supply for both mill and factory has been centralized in a



Inside the cable bridge showing the arrangement and method of carrying the feeders. The 2,300-volt lines to the bear-

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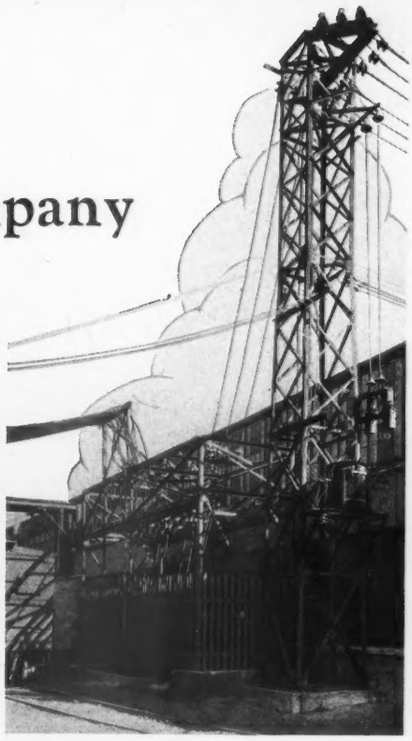
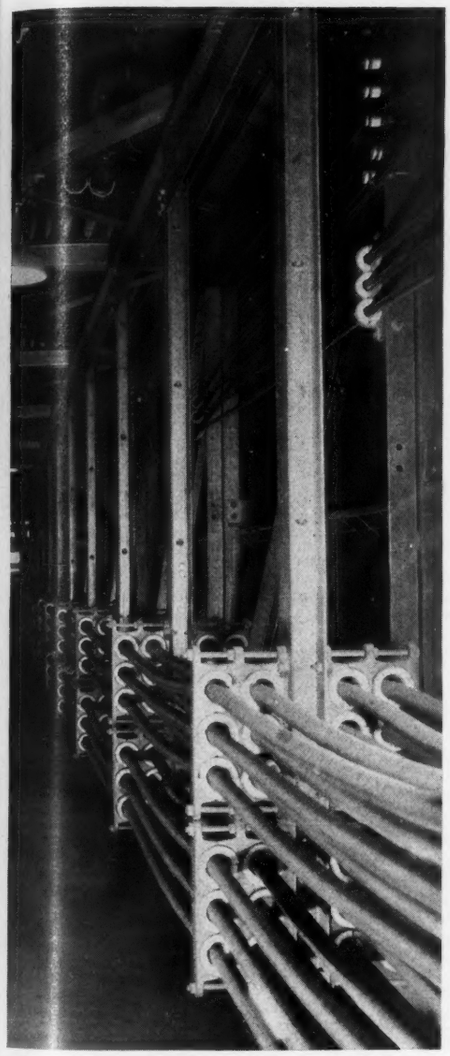
single 45,000-kva. substation, located near the physical load center. The primary source of power is the 22,000-volt lines of the Ohio Power Company, which are brought direct to the station from a nearby transformer station on the power company's high-tension net work. The plant substation serves three purposes: a sectionalizing point for the high-tension lines; a primary transformer station for 2,300-volt power;

45,000 Kw.

the Timken Roller Bearing Company



One of the 1,500-kva. transformer stations that supply low-tension power to the bearing factory. This is the station marked *A* on the map.



ing factory are in the roof, and the a.c. and d.c. feeders for the steel mill along the walls. Viewed from the substation side.

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and a conversion station for supplying d.c. power. In addition, it supplies all the compressed air for the steel mill and factory, lighting and service power and d.c. magnetizing current for a number of magnetic chucks in the bearing factory. The total load of the plant is divided about as follows: An electric furnace load of 30,000 kw., which includes an annealing furnace load of 6,000 kw. and an arc-melting furnace load of about 24,000 kw. The low tension a.c. load, consisting of motors mostly, amounts to approximately 12,000 kw., and the d.c. load to 9,000 kw. or thereabouts.

The equipment and operation of the substation is easily described. The incoming 22,000-volt lines are brought directly to a control and distribution bus located on the roof. The power supply lines for the electric furnace load, both melting and annealing are taken directly from this bus. The same is true of the primary lines to the bank of three 6,667-kva. 22,000/2,300-volt, single-phase, 60-cycle outdoor power transformers, which furnish 2,300-volt power to the plant, and to the substation service lines.

The conversion equipment consists of three synchronous and two induction motor-generator sets of various capacities. Included in the former are one three-unit set consisting of two 1,500-kw., 250-volt d.c. generators driven by a 2,300-volt, 5,000-hp. synchronous motor, and two three-unit sets, each consisting of two 1,500-kw., d.c. generators driven by a 7,500-kva., 2,300-volt synchronous motor. The two induction sets are those used to supply magnetizing current to the bearing factory and consist of 50-kw. generators driven by 75-hp., 2,300-volt induction motors.

Compressed air is supplied by a bank of six synchronous motor-driven compressors of varying capacities. All of the motors are operated from two 2,300-volt group buses, which are supplied from the main 2,300-volt plant bus. The main bus is sectionalized so that one of the group buses is always energized, and one of the motor generators, and at least three air compressors, are always available.

Since the steel mill load is the most involved perhaps it should be considered first. As has been stated, the 22,000-volt power for the furnace loads is tapped directly off the main 22,000-volt bus through oil switches that serve as sectionalizing switches as well as protective breakers. The line for the melting furnace supply is carried on overhead standards mounted on the roofs of the intervening buildings to the furnace house, the individual furnace transformers being connected to it directly through oil switches. The 22,000-volt supply for the bank of electric annealing furnaces is also carried outdoors to a point directly over the bay where the furnaces are located. It is there brought into an indoor 6,000-kva. transformer station where it is stepped down to the working voltage by a bank of 22,000/440-volt power transformers. As the furnaces are all grouped closely about this station, it has been possible to supply them from a common 440-volt bus without much expenditure for copper, or excessive voltage drop in the lines. The furnace bus has been sectionalized so that, in case of failure of any furnace protective equipment to operate in emergency, the trouble will be confined to that particular furnace.

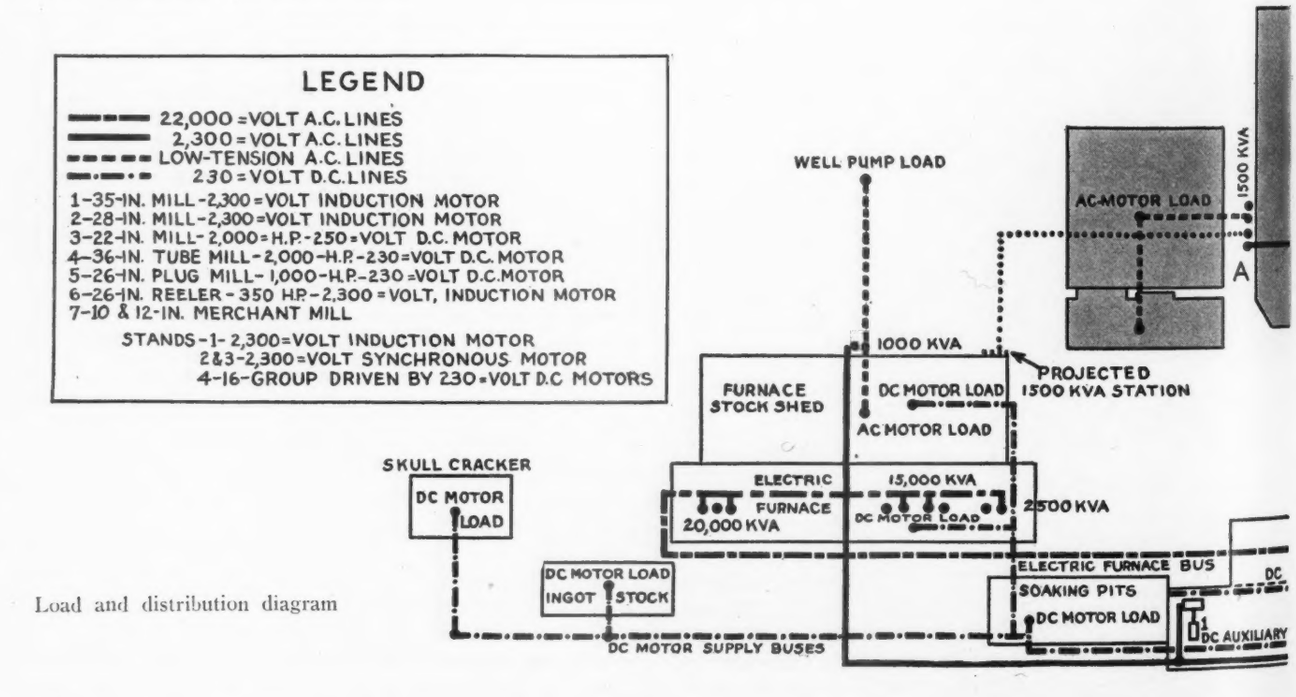
The arrangement of the 2,300-volt steel mill supply circuits is quite different although the same general method of control and protection applies. As has been said, the 2,300-

volt power from the main transformers is delivered to a common bus in the station. The individual supply feeders for the mill are all taken off the main bus through oil switches and run directly to the point of utilization. The insertion of oil switches between the supply feeder and the main bus serves two purposes; it gives an extra point of control on the circuit, and it isolates that particular circuit in case of trouble. Thus disturbances on any supply circuit cannot, in case of failure of the individual protective devices, work back to the main bus and involve other circuits, or cause a general outage.

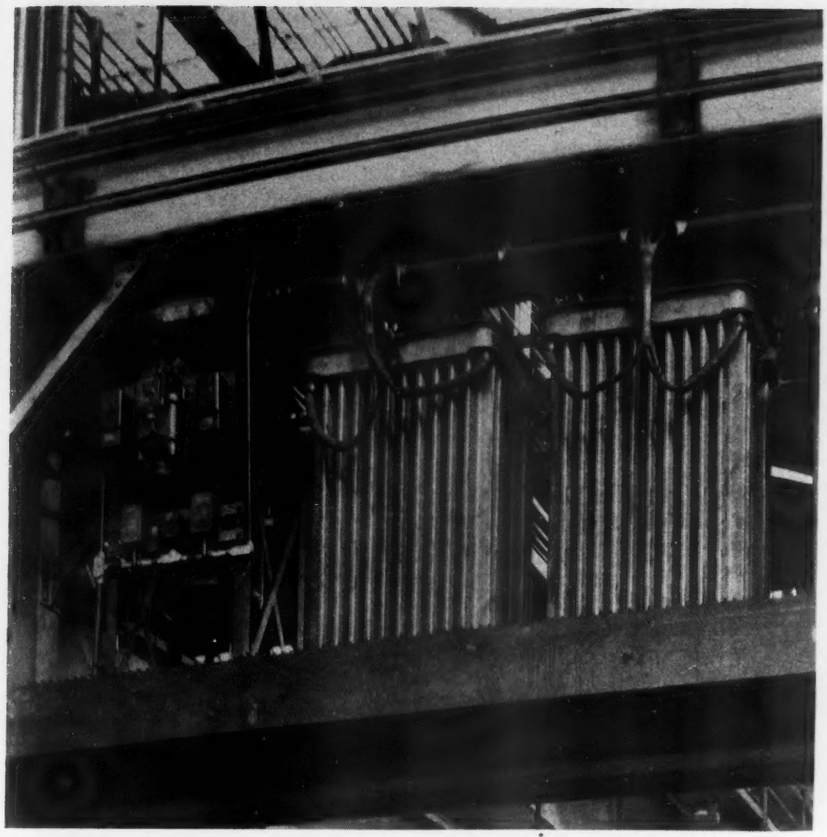
From the switchboard, the feeders, in the form of cables, are carried to the mill on an overhead cable bridge, from which they are carried to their several destinations by cable racks located either high upon the mill walls, or near the ceiling. The majority of the supply feeders carry power to operate 2,300-volt, main-drive mill motors, but three of them go to transformer stations located in the mill.

The transformers in two of these stations, one of 1,500-kva., and the other of 450-kva. capacity, step the voltage down to 220 for use on various machine and auxiliary equipment drives. The other furnishes 440-volt power to operate the motor-driven

Substation entrance to the cable bridge. The 2,300-volt feeder conduits are carried near the ceiling, and the mill d.c. and a.c. lines are those going through the wall on either side of the door. The 2,300-volt feeders for both steel mill and bearing factory are controlled by a bank of oil switches located in the substation basement.



Load and distribution diagram



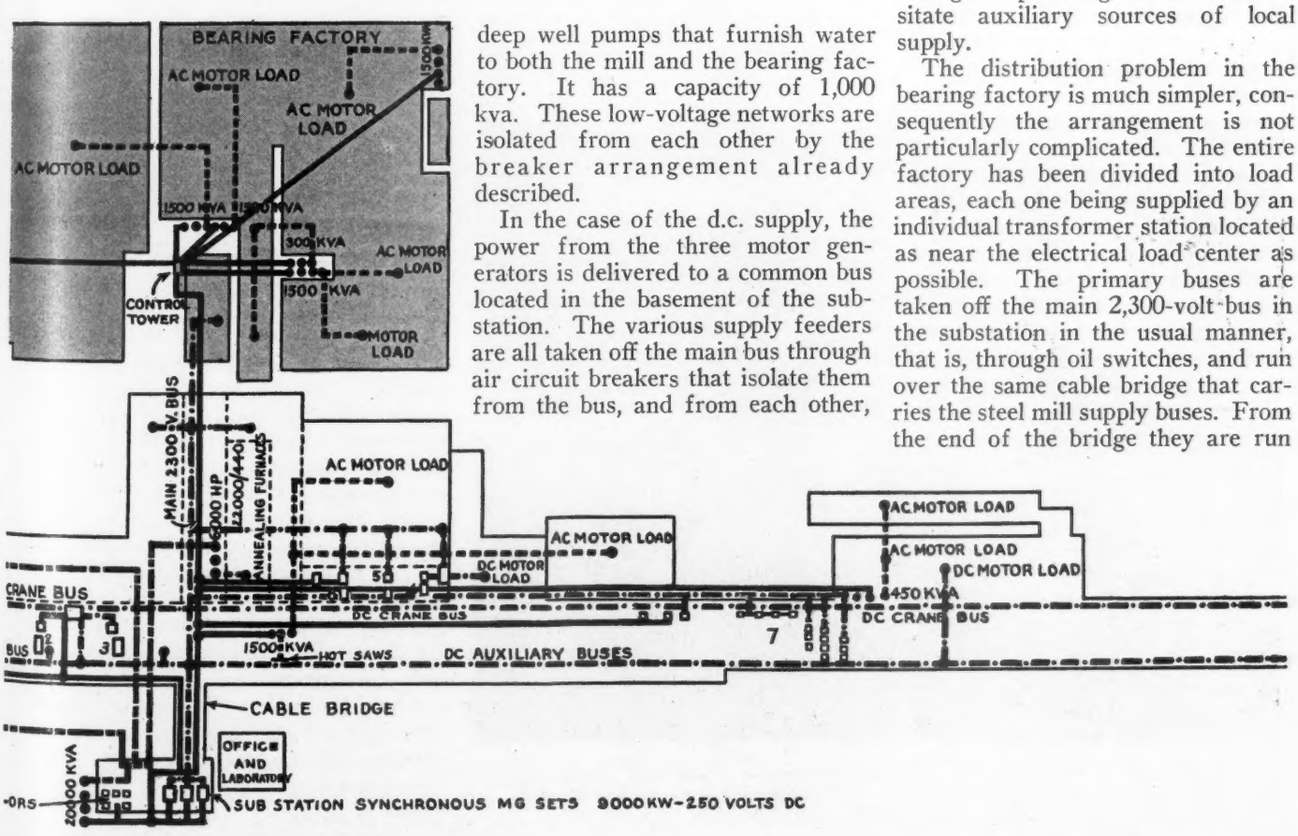
The 450-kva. transformer station that supplies 440-volt power to operate certain machine drive motors. The illustration also shows how the supply feeders are carried about the mill. Power for cranes and other drives in isolated buildings, and for such main-mill motors utilizing direct current, is supplied by individual feeders.

in case of trouble, The feeder cables are carried from the basement to the substation end of the cable bridge in conduits, and over the bridge on wall brackets.

One advantage of this system is that it makes circuits easy to trace, and also renders them readily accessible for repair or inspection. The fact that the mill is long and narrow, and that both auxiliary drives and cranes are in alignment from one end to the other has simplified the feeder system considerably. For instance, the five cranes in the mill run on the same track, and are supplied by two feeders which are connected to a common crane bus. This arrangement means a considerable saving in copper over what would be necessary if the cranes were run on individual tracks in different parts of the mill.

The auxiliary drives are supplied in groups, the drives for the auxiliaries of each mill unit constituting a group. The feeders run along the mill wall, and are carried in conduit down to the point where the motor connections are taken off. Power for crane and other drives in isolated buildings, and for such main-mill drive motors that utilize direct current, is supplied by individual feeders. The d.c. load is, however, well concentrated in the mill building proper so that there is not enough voltage drop in long feeders to necessitate auxiliary sources of local supply.

The distribution problem in the bearing factory is much simpler, consequently the arrangement is not particularly complicated. The entire factory has been divided into load areas, each one being supplied by an individual transformer station located as near the electrical load center as possible. The primary buses are taken off the main 2,300-volt bus in the substation in the usual manner, that is, through oil switches, and run over the same cable bridge that carries the steel mill supply buses. From the end of the bridge they are run



deep well pumps that furnish water to both the mill and the bearing factory. It has a capacity of 1,000 kva. These low-voltage networks are isolated from each other by the breaker arrangement already described.

In the case of the d.c. supply, the power from the three motor generators is delivered to a common bus located in the basement of the substation. The various supply feeders are all taken off the main bus through air circuit breakers that isolate them from the bus, and from each other,

in a straight line to a common terminal tower mounted on one of the buildings almost equi-distant from all the transformer stations.

At the tower the lines separate, being carried to the transformer stations over the roofs of the intervening buildings. In all there are six stations of 1,500-kva. capacity. They are located outside of, yet close to the buildings and surrounded by high protective fences. In these stations the 2,300-volt power is stepped down to 440 or 220 volts, as the case may be, to supply the factory motor load.

The low-tension power is carried to the motors in steel conduits located for the most part near the ceiling of the various rooms. The entire system is thoroughly protected; on the secondary net works by the usual motor protective systems; with fuses at the transformers, and on the primary side by the switches in the substation. One feature is interesting, namely, that owing to the scheme of carrying the primary conductors over the roofs of the buildings, and the secondary circuits in exposed conduit near the ceilings, every circuit is easily accessible at every point from the main supply bus in the substation to the last motor connection in the factory. Thus, it is not only easy to trace an entire net work from one end to the other, but repairs and inspections are easily made.

The magnetizing current for the magnetic chucks in the bearing factory is brought direct from the motor-generator set to the machines by a three-wire circuit that parallels the 2,300-volt bearing plant circuits.

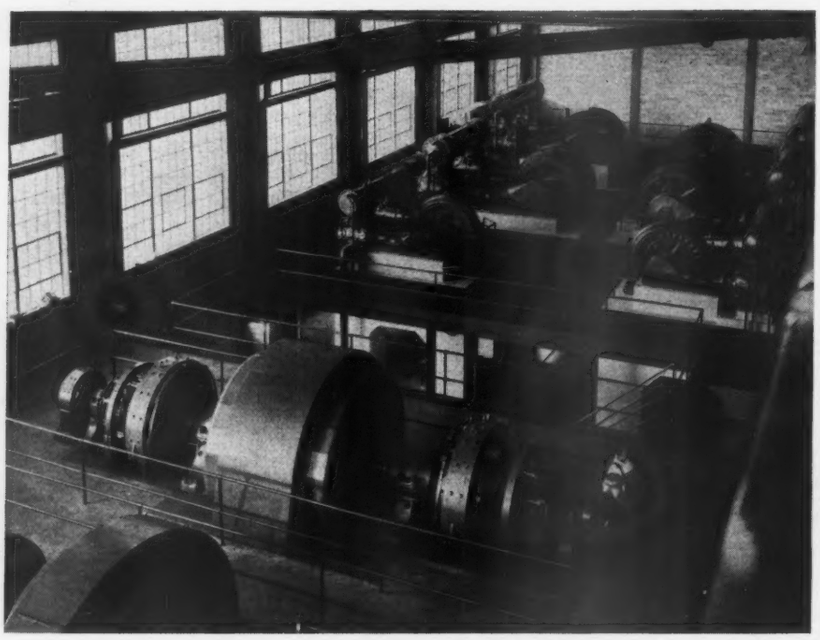
In a general consideration of the system as a whole, one fact is well worth considering, namely, the matter of power factor correction. With a large, not to say preponderating electric furnace load, such as exists in this case, added to a large induction motor load with a poor load factor, the ordinary result would be a very poor overall power factor. Electric furnaces, and especially electric arc furnaces, are notorious in this respect.

The 2,300-volt bearing factory lines do not offer much opportunity in this respect because of the low individual horsepower ratings of the motors making up the load. The 2,300-volt mill lines do, however, offer an opportunity for correcting the overall power factor, and so do the station service lines. As a matter of fact, both these lines have been utilized for the purpose, a large part of their joint connected load being made up of synchronous motors whose duty cycles call for continuous operation, so that the corrective effect is also continuous rather than spasmodic. As a result the overall power factor of the plant load at the metering point, which is the Sunnyside station of the Ohio Power Company, is practically unity.

The advantage of a metered, high power factor in the case of a load of this magnitude need hardly be emphasized. In the case of the bearing factory, power factor hardly enters into the question one way or the other. The load is mostly inductive, but the majority of the machines are group driven and most of them are automatic, two conditions which permit induction motors to operate at their best power factor. The bearing factory does make one contribution to the general benefit however, which is a result of supplying the whole load from a single source—it tends to bring up the general load factor.

In the steel mill the load factor is low, as it is in most steel mills, and it is made worse instead of better by the melting furnaces. In fact it is so low that the comparatively small continuous load supplied by the motor generators and compressors in the substation can have but little effect on it. The presence of a large, even, and continuous load as is that of the bearing factory, in conjunction with the substation service load, does much to raise the overall factor to a respectable figure.

So, on the whole, in spite of the difficulties experienced, in supplying such an unusually diverse load from a single source, the experience of the Timken Company tends to prove that it pays, if the various problems are carefully worked out. For this reason if no other, the installation is interesting, as showing what can be done, by careful planning, towards overcoming real obstacles in the way to efficient and economical power distribution.



Main floor of the substation. The synchronous m.g. sets that supply d.c. power are in the foreground. Six synchronous motor-driven compressor units are shown in the background.

Radio "Salutes" to Industry

AN unusual series of radio programs is being broadcast over the WJZ network by the Westinghouse Electric and Manufacturing Company. Known as "salutes" to different industries these half-hour programs consist of a combination of music and talk portraying the development of the industry selected.

The salute to pumping and irrigation is scheduled for Dec. 18.

Other industry programs will be developed for the balance of the 52 half-hour periods.

Up to the present time salutes have been given to the iron and steel industry, aviation, the paper industry, the food industry and the textile industry.

Gasoline tractor and trailer used in handling castings within the foundry.

Scheduled Lubrication

puts trucks and trailers on the spot

LUBRICATION is not a panacea for all maintenance ills, but regular application has the potency of a charm in deferring or expediting equipment replacement. Irregular application is possible with the most modern devices available, and after all there is no excuse for it. Scheduling the application is just as important a function as scheduling production. And where it is done as at the plant of the Lakey Foundry Company, Muskegon, Mich., it insures that the equipment is put "on the spot" regularly.

Scheduled application on trucks and trailers in the materials handling system has received considerable attention and a method has been devised that is simple and decidedly effective. The company operates two foundries, one producing cylinder blocks for gasoline engines at the rate of some 1,200 castings per day, and the other smaller engine parts, flywheels, cylinder heads, flywheel housings, and the like, at the rate of about 120 tons per day. The material handling equipment in the cylinder block foundry consists of a fleet of 150 shop trucks especially built for the service and two gasoline tractors. The equipment in the other foundry includes 50 shop trucks and one tractor.

The handling procedure in the cylinder block foundry is briefly as follows: Trucks are spotted at the end of four continuous mold lines, where they are loaded with hot castings directly out of the flasks. When loaded a truck is picked up by a gasoline tractor on its regular rounds and hauled to the cooling shed, an empty truck being left in its place. After remaining in the cooling shed about 24 hours, to allow its load to cool, the truck is hauled to the shakeout machines. The castings are shaken out and loaded on another truck already spotted at the delivery side of the machines, whence they are hauled to the cleaning barrels. The original truck is then moved around to the other side of the machines and loaded with cleaned castings for transportation to the tumbling barrels. After being unloaded at the barrels the trucks are made up into a train and returned to the molding lines.

It can readily be seen that the success of a simple circulating system such as this depends on the continuous fitness of all the trucks. Outage of even a small percentage would result in an accumulation of castings at some one point that would hamper production materially. And continuous service from the trucks in turn depends in a large measure on careful maintenance, which, in this particular case, is largely a matter of proper lubrication. It is true that the bearings with which the trucks are equipped, and on which the brunt of the service falls, render actual lubrication procedure a comparatively easy matter, but do not diminish its importance. The scheme was adopted as a means of securing proper lubrication for the trucks and trailers only.

The trucks are all numbered in two series, each having a foundry number and a truck number, both so located as to be plainly visible even from a distance. A lubricating station has been located at a point between the tumbling barrels and the molding lines where all the trucks pass on their way from one to the other. A lubricating chart, kept in the station, is divided by truck numbers and weeks of the year, so that it forms a complete record of the lubrication of each truck at any given time. Thus, by a glance at the chart, the man in charge can tell exactly what trucks are due for attention on any particular day. The usual pro-

Foundry service is notoriously hard on mobile equipment. Loading a truck at the end of one of the molding lines.

The truck number can be seen on the side of the frame.

cedure is for him to make a list of truck numbers needing attention at the beginning of the day, and check them off as the trucks are lubricated, entering the information on the chart at the same time.

Owing to the location of the station, it is an easy matter for him to spot numbers on trucks in the train going by on its way to the lines. If numbers correspond to those on his list, he has the trucks cut out of the train, lubricates them, and has them ready for the tractor on its next trip. At the same time he has the opportunity to inspect them for minor defects that immediate attention will correct. Once lubricated and inspected the truck is marked, as an additional means of identification, with a large painted spot on one corner of the frame, the colors alternating red and white from one week to the next. So the occupant of the lubrication station has two methods of determining the lubrication status of any particular truck, one of which serves as a check on the other.

As a result of the scheme, one man takes care of the lubrication and inspection of from 30 to 40 trucks a day without holding up the operation of the material handling system. Also, the lubrication of every truck in the system at least once a week is assured, which is very important to insure their fitness for work under the conditions of the service. The scheme undoubtedly has contributed much to the general effectiveness of the material handling system as a whole. Delays are eliminated, and still incipient troubles can be detected and remedied before they have a chance to develop to serious proportions. And, not the least important, any necessity for a nonproductive investment in the shape of a large or even medium supply of reserve equipment is completely eliminated.

Incidentally, while such a scheme may not be generally applicable, it at least forms a basis for the solution of similar problems that can easily arise in the development of other systems where simplicity and effectiveness are primary requisites.

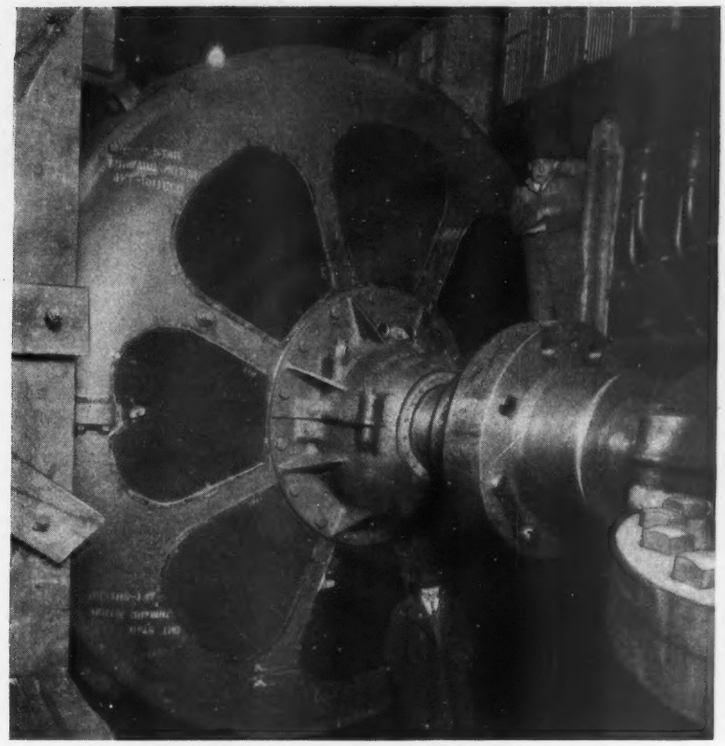
Choke Coils to Pass Out of Picture

AS a result of the development of the artificial lightning generator, the cathode-ray oscillograph or millionth-of-a-second camera, and other devices for the production and measurement of lightning-like voltage surges, it has been determined by General Electric engineers that choke coils are not useful accessories to lightning arrester installations.

For more than thirty years it has been standard practice in the electrical industry to use choke coils in connection with lightning arresters for the protection of apparatus and transmission lines against damage caused by lightning and high-voltage surges.

However, the true value of the choke coil could not be determined until exacting tests could be made on an actual transmission line.

These recently completed tests using wave shapes corresponding to the range of actual lightning waves recorded during the past two years, show that the choke coil does not aid the performance of modern arresters, and does not reduce the stress on the transformer or other apparatus and under some conditions may even be detrimental to the service. These tests are quite conclusive, so that the choke coil is no longer considered as a useful accessory to any lightning arrester installations, and consequently their manufacture and sale has been discontinued by the General Electric Company.



One of the two 22,500-hp., two-speed motors installed in the U. S. S. Saratoga.

What Multi-Speed Motors Offer to Industry

By R. H. ROGERS

Industrial Engineering Department
General Electric Company
Schenectady, N. Y.

MULTI-SPEED motors are polyphase induction motors having two or more synchronous speeds. The synchronous speed of an induction motor is that which would be obtained under an absolute no-load condition and is from 3 to 5 per cent more than the normal, full-load running speed. Synchronous speed is determined by multiplying the cycles per second by 60 and dividing the product by the number of pairs of poles; hence, if a motor can be made to have different numbers of pairs of poles, it can have different synchronous speeds.

The accompanying table shows the synchronous speeds for various numbers of poles and typical frequencies. The speeds given would be actual speeds for synchronous motors. Induction motors have a "slip" of a few per cent, varying with the load.

Multi-speed motors are usually of the squirrel-cage type, although wound-rotor or so-called slipping motors are sometimes built for multi-speed service. The number of poles is changed by means of a pole-changing switch which regroups the windings.

With a single stator winding on 60 cycles, it is possible to have synchronous speeds of 1,800 and 900 r.p.m. by using four- and eight-pole groupings of the stator winding. By grouping the windings into six and twelve poles, the corresponding speeds are 1,200 and 600 r.p.m. Corresponding speeds are obtainable on other frequencies.

With a single winding it is possible to get only two groups of poles, and they must be in the ratio of 2:1; for example, two and four poles, or six and twelve, and so on. By imbedding two separate stator windings in the same slots another set of changes becomes available such as two and four, six and eight poles. A common selection of speeds for this class on 60 cycles is 1,800, 1,200 and 900 r.p.m., or 1,800, 1,200, 900 and 600 revolutions per minute.

Other combinations of polar groupings are available, giving combinations of synchronous speeds ranging from 3,600 r.p.m. for some motors, down to 300 r.p.m. for others on 60 cycles. This total range is hardly feasible however, in one motor. The lower the speeds selected, the more poles there must be, the power factor is lowered and the motor cost is increased.

Wound-rotor or slipring induction motors, if used with resistance in the rotor circuit, have the advantage of providing intermediate speeds which, however, vary with the load. These motors are able to cover a wide range

of speed without the excessive losses and the lack of stability that ordinarily accompany speeds below synchronism in wound-rotor motors.

Multi-speed motors are controlled by the usual methods for normal motors, and have in addition a pole-changing switch by which the number of poles is changed while the motor is disconnected from the line; except for small sizes, it is not feasible to change from one synchronous speed to another while the motor is operating. The reason for this is that the pole-changing switch is a comparatively slow speed sliding contact device that does not have sufficient current-rupturing capacity for breaking the circuit under load without excessive flashing and burning of the parts. Motor capacities of 15 hp. and below at 440 volts or less can be handled by a well-designed pole-changing drum switch, but if used frequently the maintenance would become burdensome.

The compensator or the magnetic starter is designed for rupturing the current without damage to itself and, hence, should be used when changing speeds on larger motors, or when the speed is frequently changed on small ones.

There are undoubtedly a great many adjustable-speed motor applications in industrial fields where the much cheaper multi-speed motor would answer the purpose equally well. When it is specified that a motor must operate over a speed range of 2:1, 3:1, 4:1, or even 6:1, it may be that the high and low speed limits are the only ones actually required, with little or no demand for a graduation of intermediate speeds.

SYNCHRONOUS SPEEDS OF INDUCTION MOTORS

No. of Poles	Synchronous Speed 60 Cycles	50 Cycles	40 Cycles	25 Cycles
2	3,600	3,000	2,400	1,500
4	1,800	1,500	1,200	750
6	1,200	1,000	800	500
8	900	750	600	375
10	720	600	480	300
12	600	500	400	250

Where motors are connected through gearing, belts, or clutches to two or more independent forms of load, one multi-speed motor may serve as well as two motors of different speeds attached to the same mechanism. An interesting illustration of this feature is found in the two-speed, wound-rotor, oil-well-pumping equipment.

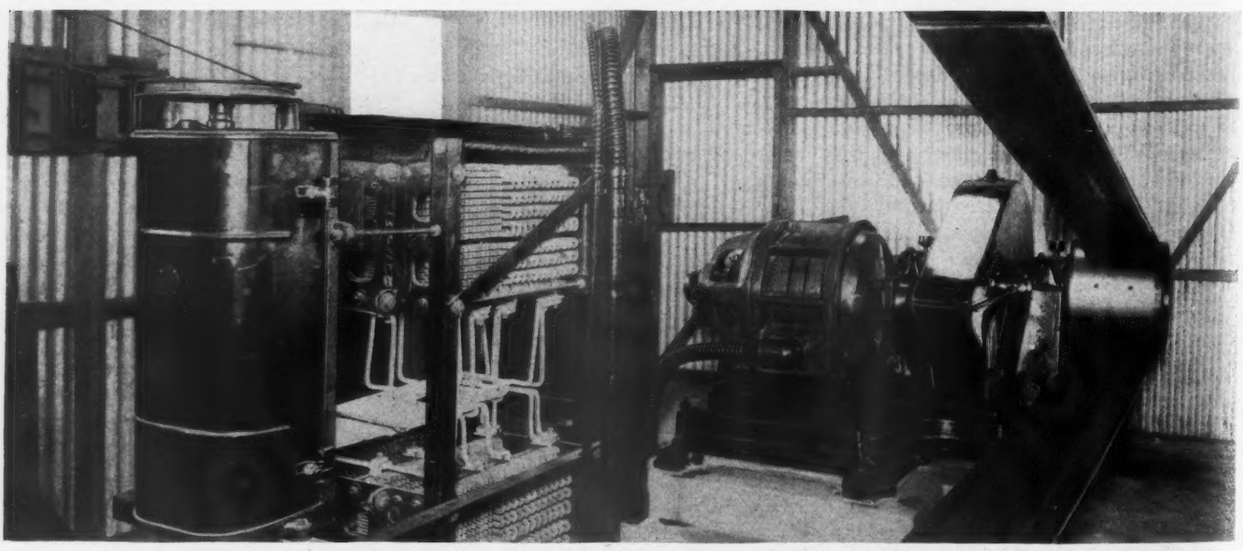
There are probably 8,000 of these motors pumping oil wells at the present time. Pumping requires a low speed, whereas servicing the well can be carried out at high speed, and includes pulling the pump, bailing, and pulling and setting casing pipe. The motor operates through speed-reducing devices which are fitted with clutches so that the power is readily transferred from the pumping beam to the hoisting equipment. The motors are of various sizes: among the larger are the 1,200/600-r.p.m., 55/25-hp. motors having six and twelve poles operating on 60 cycles.

Multi-speed squirrel-cage motors find numerous industrial applications, for example, on apparatus handling products in batches. In such cases, it is commonly necessary to start off some process operation at a low speed, and after a few minutes it may be brought up to the normal speed.

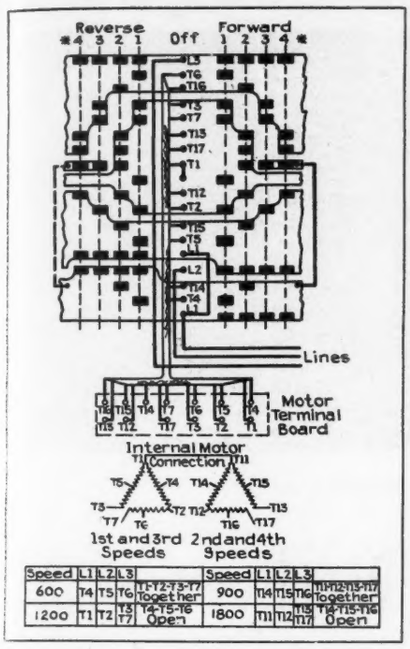
Small or slow-speed elevators, dumb waiters, and the like, are often arranged to operate at various speeds by changing the polar grouping of the motor.

Two-speed motors of great size are used in ship propulsion, some of our battleships being driven by 8,000-hp., two-phase, 24/36-pole motors on a circuit having a normal frequency of 36 cycles. The U. S. S. "Saratoga" and U. S. S. "Lexington," airplane carriers, are fitted with 22,500-hp., 22/44-pole motors operating on 60 cycles. Intermediate speeds are obtained by varying the frequency through the turbine generators. The load decreases so much more rapidly than the speed that several turbine generators can be shut down during slow-speed operations.

Although machine tools are often equipped with adjustable-speed motors to enable them to handle a wide range of work, many of them are equipped with two-, three-, or four-speed squirrel-cage induction motors, and have speed adjustments suitable for pipe cutting and threading, and other classes of more or less coarse work. In chemical plants, paper mills and other industries where a variety of pumping duty prevails, it is common practice to equip centrifugal pumps with multi-speed motors, which enable them to meet



Two-speed, wound-rotor, 35/15-hp., 440-volt, oil-well-pumping motor driving the pump beam through a silent chain and belt. The control for this motor may be seen at the left.



Speed	L1	L2	L3		Speed	L1	L2	L3	
600	T4	T5	T6	T1-T2-T3-T17 Together	900	T14	T15	T16	T11-T12-T13-T17 Together
1200	T1	T2	T3 T17	T4-T5-T6 Open	1800	T11	T12	T13 T17	T14-T15-T16 Open

Connections of drum switch for controlling 600/900/1,200/1,800-r.p.m., three-phase, squirrel-cage motor.

variable conditions of head or quantity of material handled.

In equipping centrifugal pumps or fans with multi-speed motors for full and fractional output, it is well to consider the ratios of speeds to outputs as, for example, half output will not be obtained at half speed. Woodworking machinery of the most modern type is usually equipped with an independent feeding motor for feeding the wood through the machine. The nature of the work done on the lumber requires some adjustment of the rate of feed, and this is readily accomplished by the use of two-, three- or four-speed squirrel-cage induction motors.

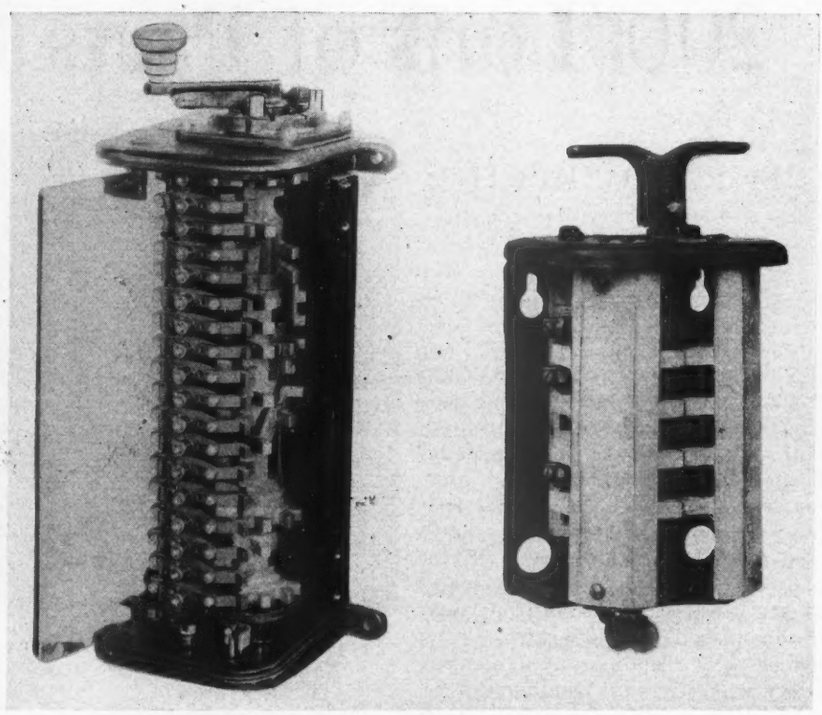
Multi-speed motors are sometimes applied on reversing service where slow speed is used for doing the work, and high speed is used to give quick recovery in preparation for the next operation. The log set-works on a bandsaw carriage is a good example of this type of application. After a plank has been sawed from the log, the motor, at slow speed, pushes the log over the required amount for the thickness of the next plank. The return, in preparation for the next move, is made at high speed, and the reversals take place about fifteen times a minute. A reversing magnetic starting switch is used and permanent connections are made from the contacts to the polar winding leads so that the switch does the pole-changing without the aid of any other device. The motor always runs at one speed in one direction and at the other speed in reverse.

Centrifugal extractors or dryers are frequently driven by multi-speed motors, the low speed being used until the bulk of liquid has been extracted, after which the high speed is used to finish the drying process. An interesting example is the recent installation of a large number of centrifugal extractors for drying a delicate material. The extractors are driven by 4/24-pole squirrel-cage motors with consequent speeds of 1,800 and 300 r.p.m. If the material were whirled at 1,800 r.p.m. with the full liquid content, it would be seriously damaged. However, after a large percentage of the liquid has been removed at 300 r.p.m. the material will safely stand 1,800 r.p.m. for the final extraction.

Two-speed, constant-horsepower motors are ordinarily listed in ratings from 1 to 25 hp. Motors for more than two speeds are not usually listed, but quotations may be obtained on them or on two-speed motors of more than 25-hp. rating.

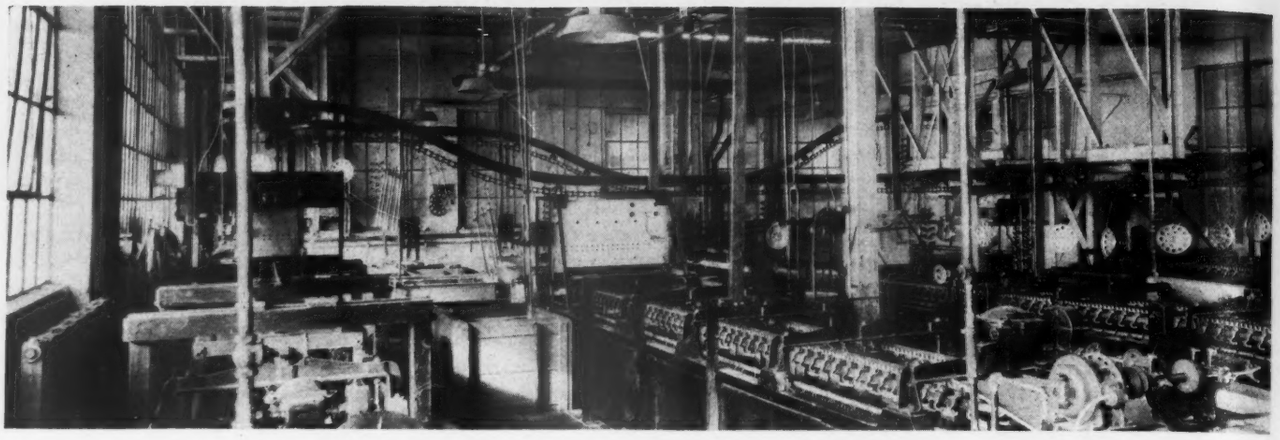
There are two general designs of multi-speed motors; one for constant-torque and the other for constant-horsepower duty. Constant-horsepower motors are recommended for operating machine tools and other devices where the load remains constant for all speeds; that is, where the torque increases as the speed decreases.

Drum switches are commonly used for pole-changing, and up to 8-hp. rating, unless otherwise prohibited, the same switch may be the starting device. For larger motors a separate starting device, such as a compensator, is required. One type of drum switch has special segments arranged for cutting off power while the handle is being moved to a new speed position, and again restoring power after the change is completed. In this way the change from one speed to another can be made, if executed quickly, by the one handle without resorting to the compensator, except for the initial start. A typical control diagram for a four-speed squirrel-cage motor is shown in one of the illustrations.



The drum switch at the left is used for changing the speed of a multi-speed motor requiring a compensator or starter for the initial start only. With small multi-speed motors the switch shown at the right may be used for both starting and speed-changing duty.

Multi-speed motors are relatively inexpensive substitutes for adjustable-speed motors on applications where a few widely-separated, fixed speeds will suffice. They are especially adapted for two-purpose mechanisms requiring two speeds. Two-, three- and four-speed motors can often supplant constant-speed motors used in conjunction with speed-changing gears, maintenance requirements being much in favor of the multi-speed motor.



The 500-ft. chain conveyor that delivers parts to the plating room.

200 Tons of Parts Daily—Our

By RAY G. RECH

Assistant Factory Manager
Syracuse Washington Machine Corporation
Syracuse, N. Y.

Belt conveyor that takes washing machine tubs to the mezzanine floor. The conveyor shown here is 80 ft. long, 24 in. wide and is driven by a 2-hp. motor through a belt drive.

IN the manufacture of several styles and sizes of domestic washing machines and ironers we are confronted with the problem of moving daily about 247,000 lb. of material. This material varies widely as to size and kind, and much of it has to be handled several times as it passes from one process to another over a space of several acres; a large proportion of the finished pieces are rather easily damaged by bending or scratching which makes careful handling necessary. Finally, all of these parts must be brought to a central point in the plant-assembly line. The completed machines must be taken to storage and then into cars for shipment.

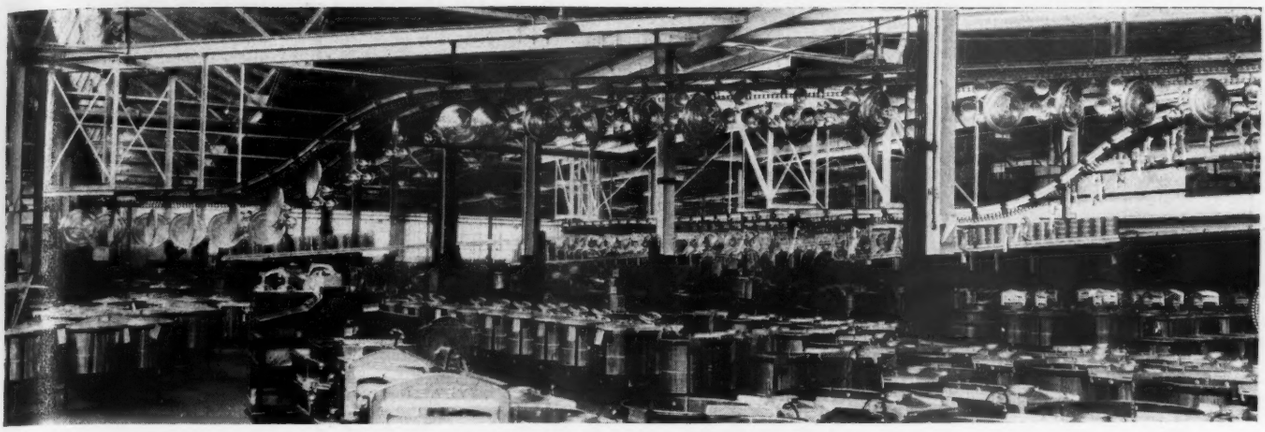
By comparison with some industries the amount of material that must be handled in our plant is not impressive. Nevertheless, the nature of the materials and the conditions under which we operate have provided some interesting problems in the development of an efficient materials handling system.

At the present time this system comprises a 2-ton, cab-operated monorail hoist, a 2-ton floor-operated traveling crane, two electric hoists, three belt conveyors from 100 to 200 ft. long, a series of conveyor chains ranging from 100 to 1,600 ft. in length, a fleet of four electric industrial lift trucks, and a high-lift tiering machine which is also electrically operated.

Incoming raw materials, which consist largely of castings, flat sheets and bar stock, come to us in containers, or in a form that facilitates easy handling. Some items, for example, are shipped in tote boxes, others on skids; copper sheets are shipped in boxes that are provided with cleats which permit the insertion of a large flat hook underneath the box so that it can easily be handled by an electric hoist, and so on. Whatever its nature, all incoming material is weighed before going into raw material stock.

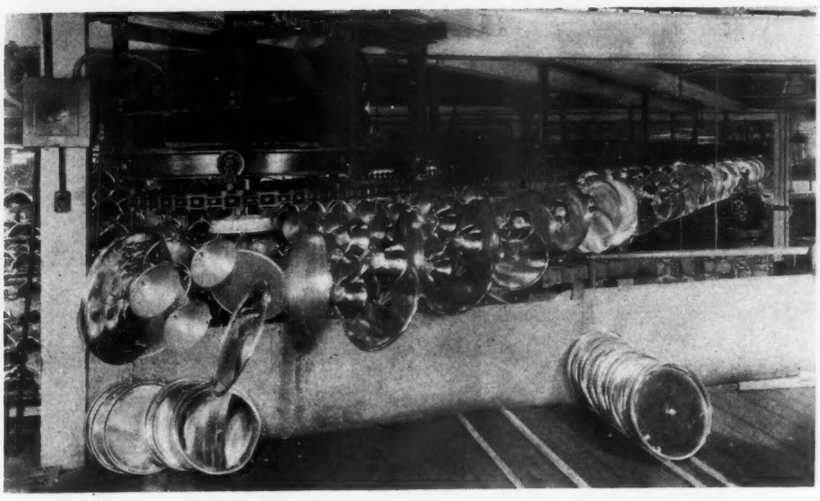
For handling the tote boxes of castings and other raw materials we use an automatic lifting mechanism of our own design which makes it possible for the operator of the monorail hoist to do the work of about 23 men. As will be seen in the illustration on page 617, this lifting mechanism, which is suspended from the hoist, consists essentially of a heavy iron frame that is slightly longer and wider than the tote box. On the underside of this frame are four levers, two at each end, that are free to slide back and forth, and engage with corresponding slots punched in the ends of the tote boxes.

In operation, the lifting mechanism is lowered until it rests on a tote box. When it is in the proper position the levers automatically slide



Chain conveyor for covers and yokes, as it appears from the assembly floor.

Materials-Handling Problem



Drive end of chain conveyor that delivers covers and yokes to the assembly line. This chain is 600 ft. long and is driven by a 2-hp. motor through a speed reducer, bevel gear, and sprocket.

into the slots in the ends of the tote box and a gong sounds, notifying the operator of the hoist that the levers are in place. When the tote box has been taken to the desired place the operator lowers it and when the tension goes off the lifting cable the levers again automatically slide back out of engagement, the gong sounds, indicating that the lifting mechanism is free, and the operator raises it for the next operation.

To save floor space, tote boxes are piled five high and this method of handling them makes it possible to pick up and remove any box on the top layer within a moment—a proceeding that would be very difficult if the work were done by hand.

Through an extensive system of parallel runways and switches, this monorail hoist is enabled to reach and serve a wide area in this department.

Rough blanking and forming operations are done by a battery of punch presses, close to the raw material storage space, so that the minimum amount of handling is required for these operations. Rough parts from these processes, as well as parts that are treated elsewhere, are taken to their respective destinations by the electric lift trucks.

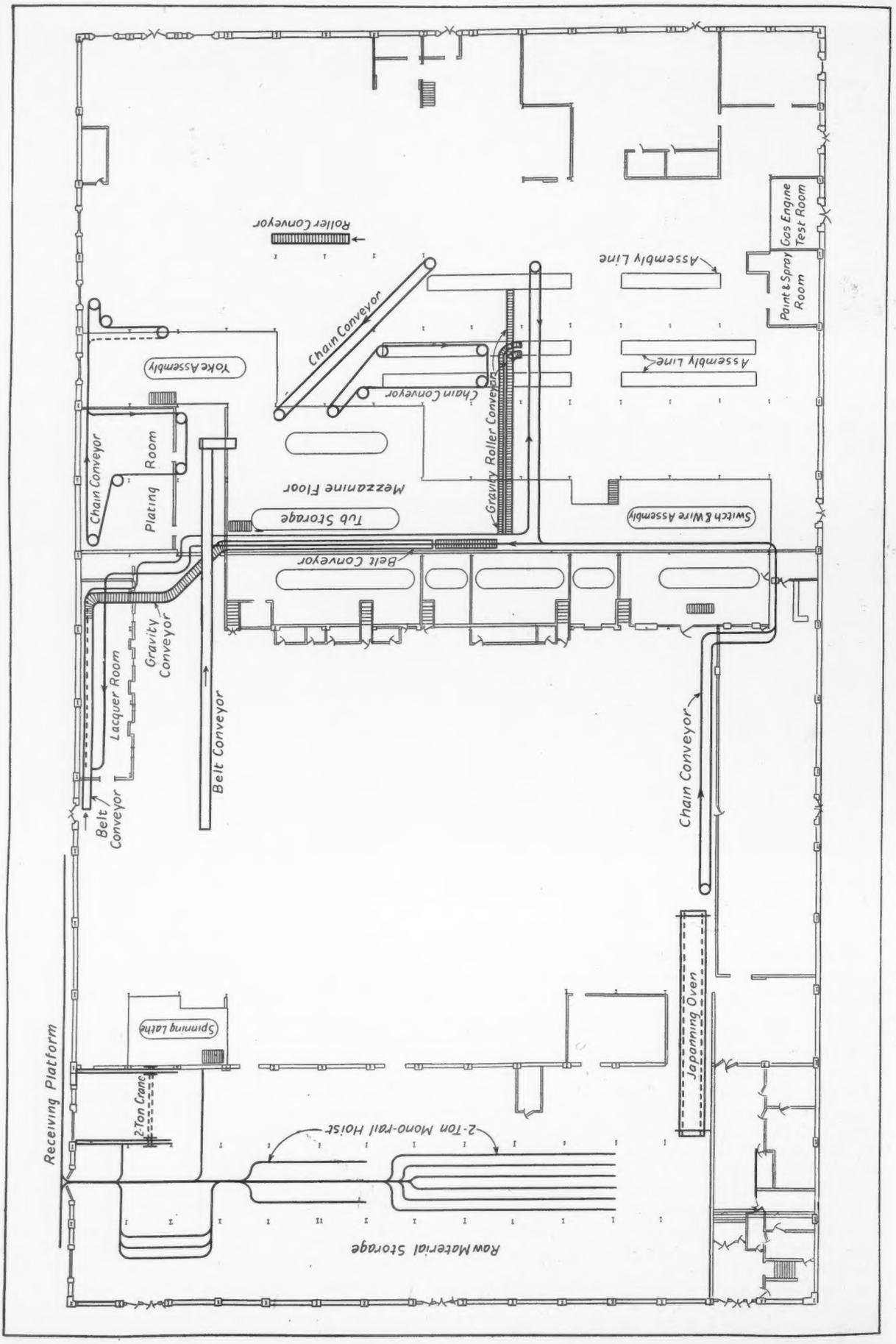
Inasmuch as upwards of a thousand separate parts are required for the different sizes and models of the machines we make, it would hardly be possible to tell how each is handled. However, a few typical examples may be selected that will show in general the method and the philosophy behind our handling system.

Bases, which are a fairly heavy iron casting, are delivered on skids to the production machines by one of the electric trucks. These machines for performing the various operations required—milling, drilling, tapping, and so on—are placed close together so that the bases can be passed by hand from one operation to the next. After the last machining operation they are again stacked on skids and taken to the assembly line.

So far as handling is concerned, the japanning operation consists merely in hanging the parts on a chain running from 28 to 56 ft. an hour, which first conveys the parts through a tank of japan and then through an oven where they are baked at 450 deg. F. On the average about one hour and 25 minutes are required for a part to travel through the japanning oven.

Other japanned parts are hung on an overhead conveyor chain that is approximately 1,600 ft. long and travels through a number of departments. Its course is shown in an accompanying illustration. This chain is driven by a 3-hp., 1,200-r.p.m. motor through a speed reducer and bevel gear sprocket drive and travels 10 f.p.m. At each department certain parts are moved from the chain and others may be put on, all traveling toward a central point, the assembly line.

Washing machine tubs, after the hand and machine operations are



Factory floor plan showing area served by monorail hoist and location of belt and chain conveyors.

completed, are placed on an inclined belt conveyor, 24 in. wide and 80 ft. long, driven at 12 ft. per minute.

The tubs are elevated somewhat above the level of a mezzanine floor, and discharged on to a short length of gravity roller conveyor, which takes them around a right-angle turn, and then discharges them on to another belt conveyor about 200 ft. long which is mounted close to the floor and serves as a combined storage and inspection bench.

After inspection the tubs are placed, according to size and model, on one of three gravity roller conveyors 200 ft. long which delivers them overhead to the assembly line.

On the rollers of this and other gravity conveyors we use both bronze-bushed and roller bearings, the number of each depending on the speed of travel desired. That is, if the parts travel faster than desired, some of the roller bearings are replaced at intervals with the bronze-bushed bearings: conversely, if the parts are moving too slowly enough of the bronze bearings are replaced with the roller type to bring the speed up to where we want it. Too high speed of travel may cause damage to the parts through bumping each other, whereas too slow speed may hold up production or assembly.

Tub covers are blanked, formed and beaded, and then placed on another 26-in. belt conveyor traveling at 12 f.p.m. and taken to the polishing department. After the required work is done in this department they are placed on a 26-in. belt conveyor 200 ft. long, also running at 12 f.p.m., which discharges them on to another belt conveyor running at a right angle to it, which takes them to the mezzanine floor. Here the handles are put on and the covers are hung on a storage chain conveyor 600 ft. long that takes them through final inspection to the assembly line. This chain conveyor is driven through a speed reducer and bevel gear sprocket drive at a speed of 45 ft. per minute.

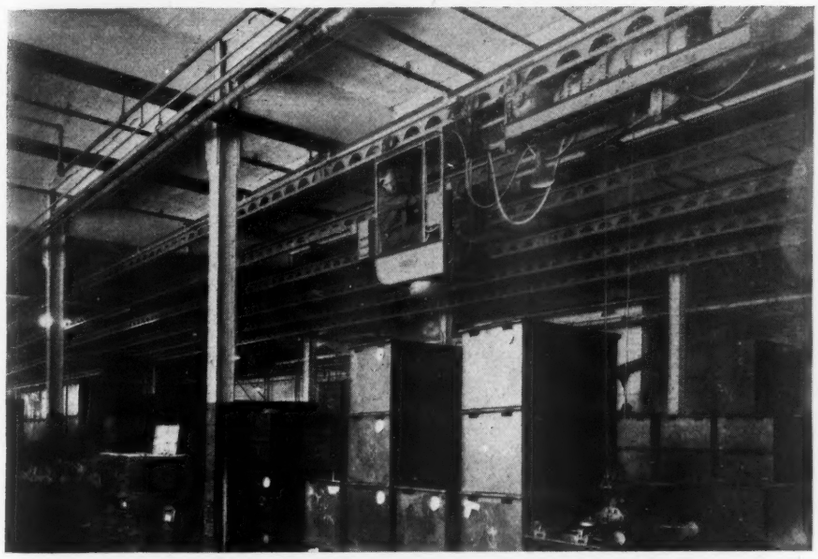
Parts that require plating are transported by a 500-ft. chain conveyor traveling 45 f.p.m. from the department in which they are made to the polishing and buffing department on the mezzanine floor. After they have been properly prepared they are again placed on this conveyor which dips down from the mezzanine floor and circles around the plating department. As the parts go by, the operators at each plating tank remove the parts for which they are responsible. If more parts are delivered than can be handled, the excess is allowed to stay on the chain and come around again.

For their journey through the plating tanks the parts, after cleaning, are again hung on a short chain whose speed of travel is adjusted so that they remain in the tank long enough to give a plated coating of the desired weight.

After plating, the work is again hung on the conveyor chain serving this department and taken to the mezzanine floor where certain parts are removed, buffed, assembled, and then taken by another chain conveyor 120 ft. long to the assembly line.

The first operations in the assembly of washing machines are performed with the machine upside down. False casters are placed on the four posts formed by the extension of the legs and the machines are pushed from one operator to the next on a slightly elevated iron runway with a guard rail on each side to keep the machines from running off. There is a break in the runway at the point where it crosses an aisle. Here the machines are up-ended and placed on the other section of runway. During this operation the false casters fall off and the machine travels the rest of the way along the assembly line on its permanent casters. After assembly, testing, and crating, the latter of which is done on a short section of roller conveyor, the machines are piled four high in the finished storage by an electrically-driven, high-lift tiering machine.

The general principles involved in handling all of the parts we make, from raw material storage to assembly line, are the same as outlined for the few specific items mentioned in the text. Obviously, a certain amount of manual handling is practically unavoidable, but we keep it down to the minimum, as our experience has shown that mechanical handling by equipment that is adequate for the job and properly laid out offers very attractive possibilities for reducing production costs and saving floor space.



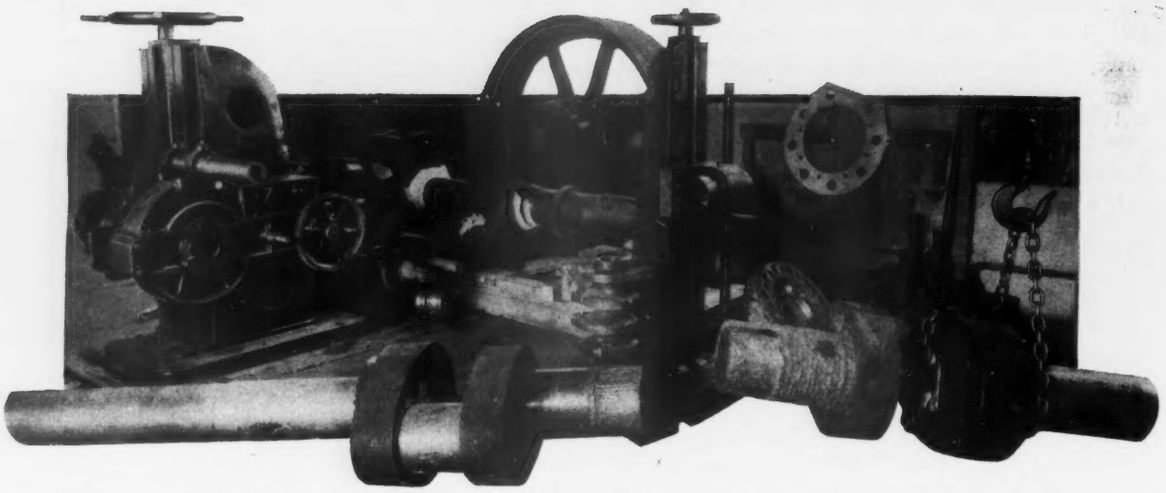
Incoming materials are handled in raw material storage by this monorail hoist. Note the special lifting mechanism for handling tote boxes.

A History of Mechanical Inventions

By Abbott Payson Usher, Associate Professor of Economics, Harvard University. Published by McGraw-Hill Publishing Company, 370 Seventh Ave., New York, N. Y. Cloth binding, size 7x9 in., 401 pages, illustrated.

IN this study of technology the author separates the history of the inventions from the discusion of their significance. No attempt has been made to point out the full economic consequences of the technical progress recorded, and though the general chronology of the development has been given much attention, the importance of the conclusion for the interpretation of the so-called industrial revolution is not developed in the present volume.

Characteristics of geographic and technical factors; the mechanical equipment of pre-Christian antiquity; water clocks and mechanical clocks, and their development into instruments of precision; Da Vinci, engineer and inventor; the production and distribution of power since 1500 suggests the treatment of the subject, which is confined to thirteen chapters.



One guess that is as good as another is that the value of the material salvaged by welding far exceeded the cost of the welding equipment.

Welding Saves the Day

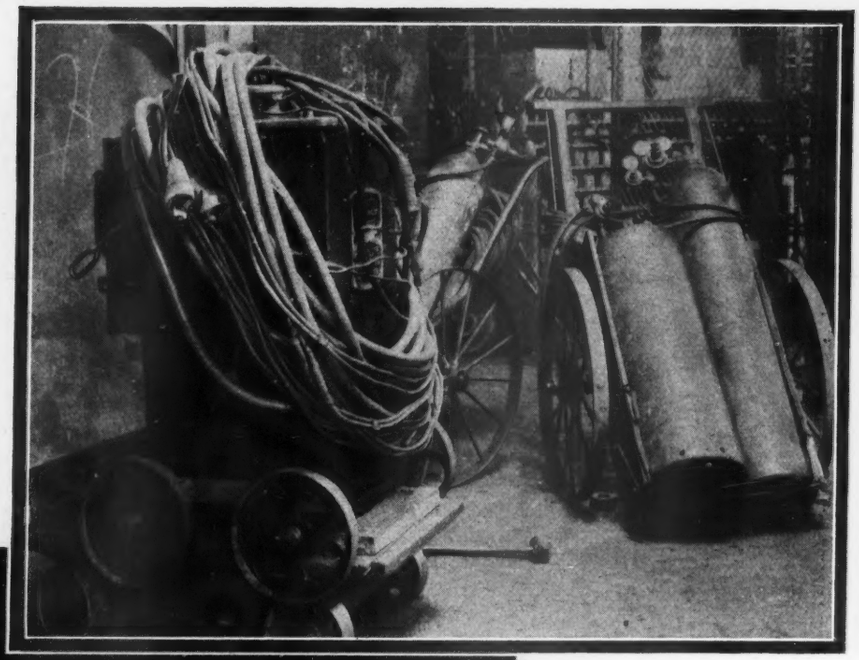
That welding equipment is a service-to-production tool is no longer questioned. Its value has been demonstrated time after time where plant operations have been seriously threatened because of failure to some part of the equipment. The plant with welding equipment on the job has the makings for "saving the day" every day.

Welding saved this gear from premature retirement despite the excessive tooth wear. Before the advent of welding multiple fractures such as are shown mended would have necessitated complete replacement.

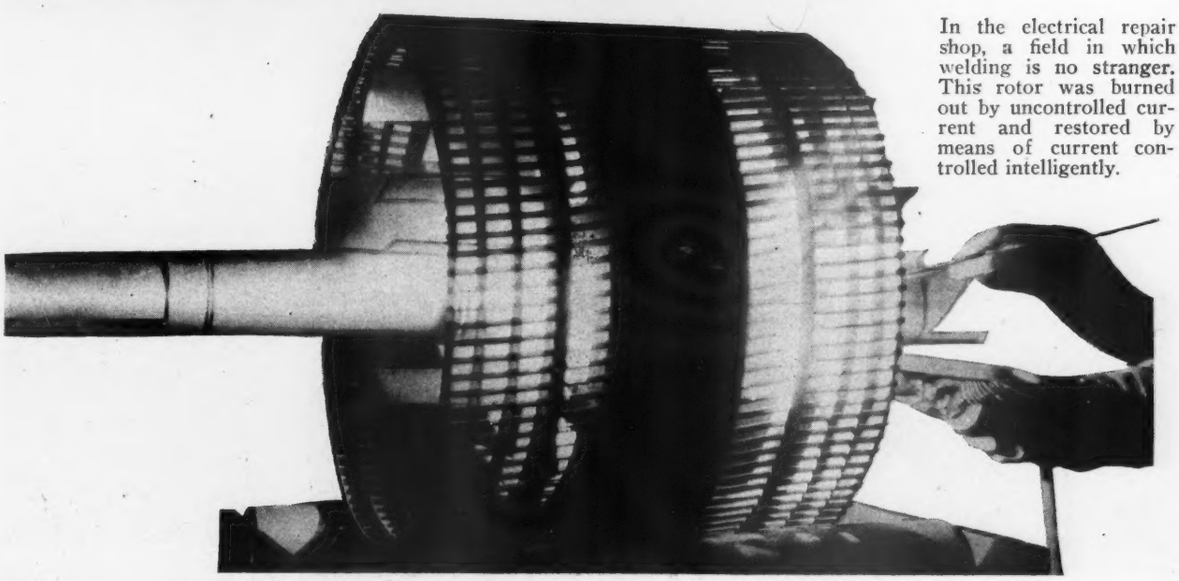
What the builder omitted can be added by welding. Added support is given to a roof by the addition of an extra roof member, which is firmly welded in place.

In this instance extra support was given the floor above by placing a supporting member beside the wall and welding it to the overhead beam.

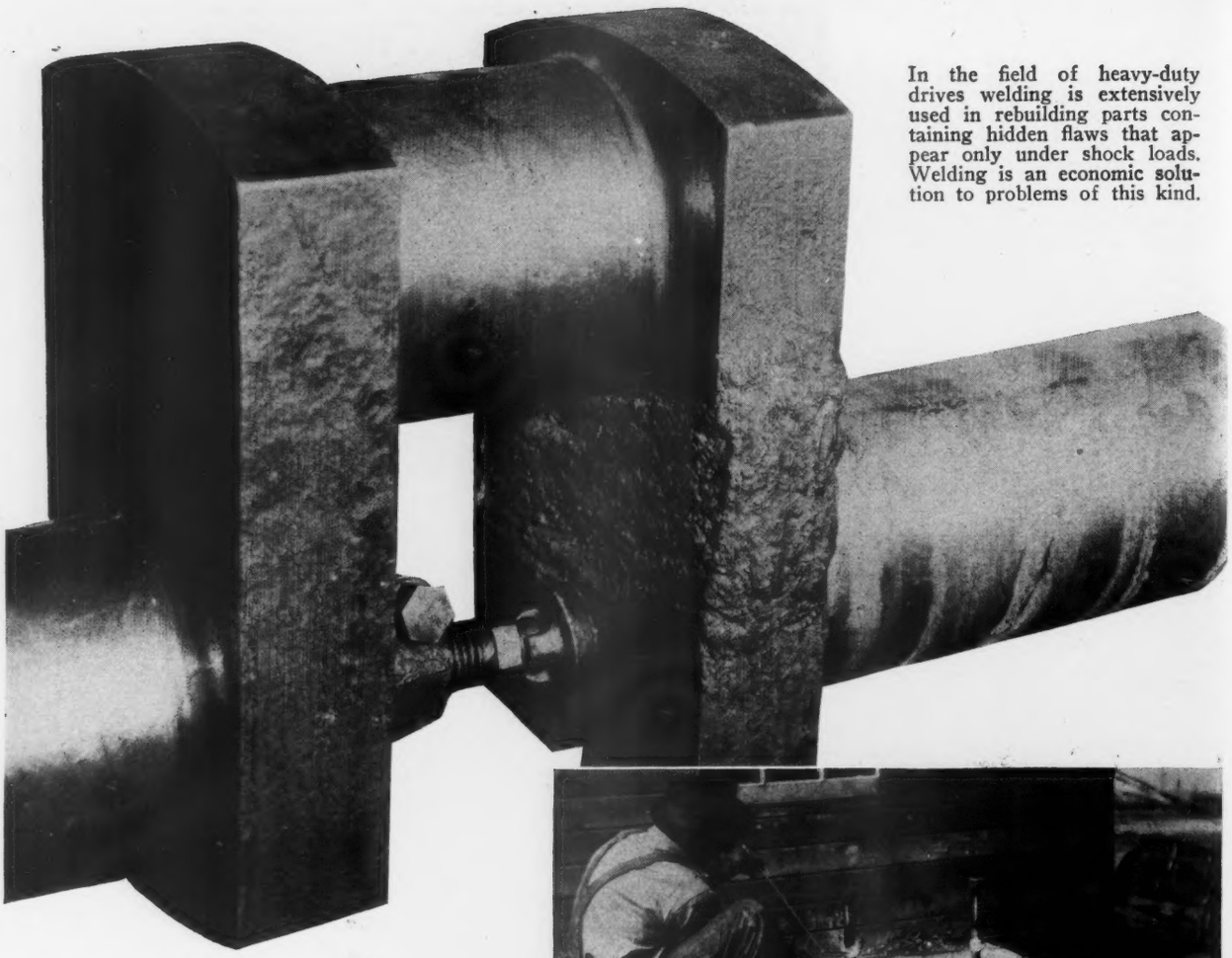
The dependence which one plant places on welding equipment is illustrated herewith. These welding outfits are held in reserve for emergencies only. When a breakdown occurs and the broken parts can be conveniently welded these portable units are rushed to the job for real service-to-production work.



In putting up this monorail installation, welding was found to be just as satisfactory a method of doing it as any other; hence its use. Supports and cross members were formed on the ground, then erected. The monorail supplies the rigidity necessary to the vertical members.



In the electrical repair shop, a field in which welding is no stranger. This rotor was burned out by uncontrolled current and restored by means of current controlled intelligently.



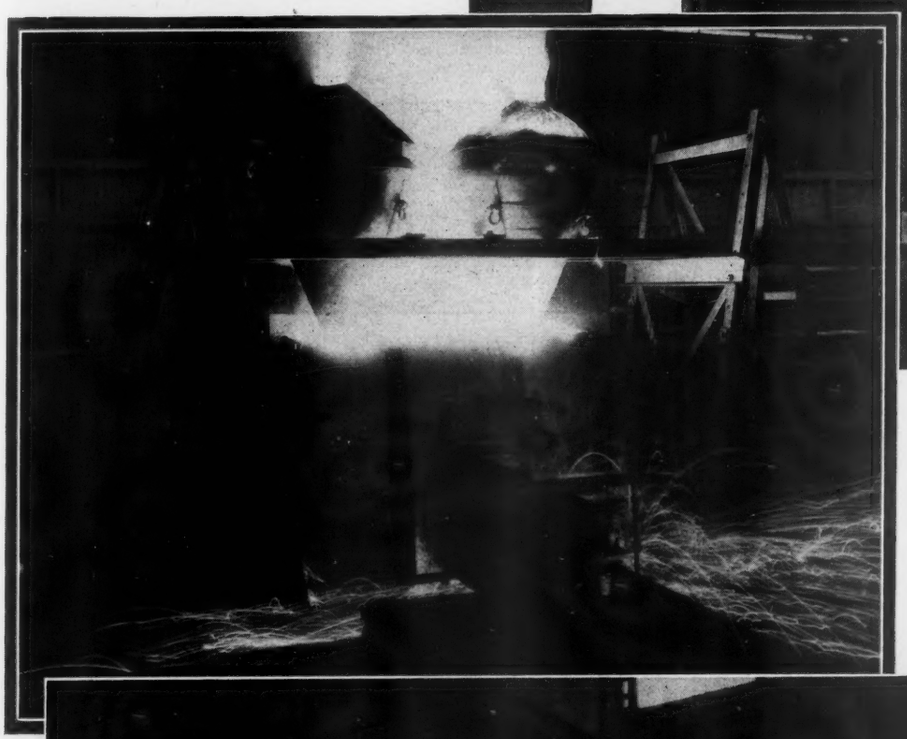
In the field of heavy-duty drives welding is extensively used in rebuilding parts containing hidden flaws that appear only under shock loads. Welding is an economic solution to problems of this kind.

An ordinary welding job saved the cost of installing a new foundation. The former anchor bolts were too short to accommodate the new construction so they were cut off, beveled and extended by welding longer sections to the stumps with ⅛-in. reinforcement at the weld.

Welding brought order out of chaos when moving day came 'round for one plant. A rack was hastily put together by welding angle-iron shapes cut to length from material on hand. Time-out for drilling, such as was necessary with the small bolted rack at the right, was eliminated.

The rivet hammer gives way to the welder in the field of building construction. Here crane supports are being welded to main columns in an industrial plant.

A thermit weld in the making. Its field is that of heavy pipe and large sections of iron or steel. Thermit melts by the heat of its own chemical action.



When the building did not lend itself to support necessary lineshafting for a machine that could not get along without it, welding enabled the plant engineer to fabricate the framework shown. The building is free from destructive vibration, which is confined to the supporting lineshaft structure.

Budgeting Upkeep Keeps Down Expenses

BUDGET 1929 New Work (Same for Repairs)					
Mill No.	Dept.	Item	Labor	Material and Outside Labor	Total

Form 1 is used in setting up the maintenance budget.

MONTHLY REPORT OF NEW WORK AND REPAIR OPERATIONS					
Plant Order No.	Mill and Dept.	Item	Budgeted	Cost	Excess or Saving

Form 2 is a recapitulation of the work done each month.

By B. A. FRANKLIN

Vice President
Strathmore Paper Company
Mittineague, Mass.

IN these days when good management is planning ahead, even to the final detail, rather than to judge merely by the past and to hope for the future, many problems present themselves. One of them is the question of how to budget for upkeep, to forecast the expense of repairs and the cost of plant development and improvement.

Before this can be done in any plant, there must be a definite policy of upkeep, as indeed there should be in every up-to-date plant, whether or not it budgets its activities.

Such a policy involves, of course, the problem of ordinary running repair, which under all conditions is necessary for a going plant. To merely keep a plant in repair in these modern days of price competition, however, is to let it go, if somewhat slowly, nevertheless surely, backward.

A second element in upkeep, therefore, is essentially involved in replacement of machinery, equipment, or even buildings, that are slow, ill balanced, obsolete, or poorly arranged for an economic routine.

A third element for consideration is that of the addition of improved appliances, of rebuilding, or redesigning equipment for better or more economical production.

There comes finally the question of increased production, if it should seem wise or essential, and the necessity it involves in planned expenditure.

With these ideas in front of it the Strathmore Paper Company tackles its annual budget of upkeep.

This budget is, in the main, a responsibility of its engineering department, but involves the heads of departments, as indeed should all planning or budgetting, if the plan or method is to meet the greatest cooperation and effectiveness.

Late in each year the chief engineer requests all superintendents and heads of departments, even office departments, to go over their physical conditions with these four problems in mind, and work out in detail what they believe to be their requirements for the coming year, the engineering department considering for itself questions of power or strictly engineering equipment.

As the reports from each department are made, the engineering department undertakes to consider them from the engineering and cost point of view, and after many conferences between the chief engineer and the heads of the different departments, there is arrived at for each department a detailed list with approximate costs.

These lists are consolidated into a typewritten folder under the two main heads of "Repairs" and "New Work," each department's requirements being kept separate, but of course with grand totals attached. A copy is sent to all executives and to all of those interested for consideration, criticism, and personal suggestion.

Then begins a series of supper and evening conferences involving all the executives and department heads for a detailed, item-by-item discussion as to the necessity, the advisability, the cost, and, the financial obligations considered, whether and when the suggestions made shall be put into effect.

In the matter of running repairs, the costs of previous years, of course, are taken as a gage of the amount to be budgeted. Replacements, improvements additions are all considered on the basis of what improvement of quality, of quantity, or economy of production they will produce and how long such improvement will liquidate the cost, or what return on the investment each will bring. Also it is settled whether the work shall be done by the engi-

neering department or by outside contractors.

These discussions often bring about the appointment of committees to re-study particular propositions. Often, of course, suggestions are considered inadvisable, even if only temporarily, although naturally some are permanently discarded as too costly or insufficient of accomplishment. A number are adopted and some definite future date set for their accomplishment. The remainder are adopted for installation in such order as may be thought most convenient.

During the year, as each of these plans agreed upon is started, a plant order is issued properly numbered, and costs are kept on each of them.

Monthly, there is issued to all concerned a list showing the plant order number, the description of the work, the budgeted amount and the actual cost, with the total cost for each department to date as compared with the budget for this particular work.

Naturally, during the year, despite the care with which the budget is made, there creep in necessities for improvement and addition, new ideas which demand immediate consideration and adoption. These are shown on the monthly list, with a cipher in the budget column.

Many advantages arise from such a plan, even though it involves a great deal of work.

The heads of departments are thinking throughout the year of how to better their sections and concentrate on the matter at the end of the year. It gives each one a feeling that his section is receiving consideration, as also are his ideas. He sees in this budget an opportunity, and he feels likewise the responsibility.

The plan brings a general and detailed co-operation of all concerned to keep their departments abreast of the times.

It saves the executives a great amount of time during the year, considering first one problem and another, and concentrates a large part of this work in a few weeks, with the full advice and discussion of all of those with experience, with all the details and cost thereto fully prediscussed.

It brings to the finance department the total amount of money necessary for this expenditure, considerable in any plant keeping up-to-date in these progressive days.

It substitutes for occasional and often individual thought, the definite and total thought of the organization.

It gives system, plan and scientific management to a large problem most often haphazardly, and often too laggardly handled in many plants.

And it pays, because it is the plant systematically and carefully kept up-to-date, which not merely lives but prospers under competitive conditions.

What Floodlighting Can Do

In this installation eighteen 1,500-watt units, with an effective range of 2,000 ft., and twenty-five 1,000-watt units to illuminate the foreground are mounted on three towers, 100, 85, and 85 ft. high. The average foot-candle intensity in the yard is 0.1. One of the 85-ft. towers is shown.

INDUSTRIAL ENGINEERING

Plant Engineering in Industry

L. C. MORROW, *Editor*

Chicago, December, 1929

Plant Engineering Opportunities in New England

FOR several years there has existed a rather general feeling that New England is not so well off industrially; that not only does she lack business, but that plants, equipment, and methods are obsolete.

In the interests of their readers, and to get a true picture of industrial New England as a whole, twenty editors of McGraw-Hill publications (your editor among them) toured the six New England states last month, visiting sixty-five plants in fifty-one cities.

They found New England much the same as other sections of the country, which means that they saw both modern and obsolete plants, equipment, and methods. They met men who are on their industrial toes every minute, and they met men who are industrially flat-footed. They were impressed by the facts that buildings, when they are old, *are old;* that the oldest equipment is found in New England; that power generation and transmission are in some plants really antiquated; that lighting, in the poorest examples. is only make-believe.

But they found, also, that there is a considerable proportion of modern plants; that the buildings of these plants are the last word in buildings; that in their lighting, heating, power transmission, and other phases of industrial operation they are just as good as can be found and, of course, they found that New England industry, as a whole, involves the use of more skilled labor, in proportion to equipment and bulk of product, than do most other sections of the country.

It is obvious that the age of New England industry is responsible for some of its obsolete buildings, just as it is responsible for some of its modern ones. The same condition holds in respect to equipment and methods. When the old finally is scrapped only the best is allowed to take its place. Unfortunately, there is more than a tendency to hang on to the old too long.

The favorable industrial factors in New England are: Diversification; a plentiful supply of skilled labor; an awakened group of executives; growing recognition of the necessity for progressive materials handling equipment; a recognition that research in industry is essential; improvement in personnel relations; high capacity to absorb released labor; modern buildings; good freight conditions; and progressive electric power service.

In contrast, are these factors: Adherence to obsolete equipment; poor lighting, both natural and artificial; neglect of ventilation, painting, cleaning, sanitary facilities (poor housekeeping); lack of practical safety methods; still too much hand work; not enough use of materials handling equipment; an inclination toward too large inventories; still too little attention to personnel problems; too many obsolete buildings.

It is not difficult for the plant engineers of New England to see that they have a real opportunity ahead of them, an opportunity especially attractive because of the splendid spirit in favor of modernization that exists among the plant executives. These engineers must keep themselves up to the minute, even in the face of some delay in getting the orders to go ahead.

The cycle between modern and obsolete is, naturally, completed first in New England, the oldest part of the country. But time is at work regardless of geography, and there is a similar incentive on the part of plant engineers everywhere to keep abreast, forestalling, where they can, the steps in the cycle that make for obsolescence.

Substituting Instruction for Reprimands

BITTER complaints are sometimes heard about the lack of responsibility and don't-care attitude shown by many workmen. It is undoubtedly true that real craftsmen—men who know their calling thoroughly and who are conscientious enough to do the best job they can—are relatively scarce, and probably always will be. For one thing, such men naturally travel toward foremanships and higher positions, and seldom have to seek employment.

The other side of the story is that plant engineers and other executives do not always take the time to see that the men under them, particularly new employees, are given enough training on the details of the job and how the work should be done. Under these conditions it is inevitable that neglect and mistakes will be in evidence, but they are as likely to be the result of ignorance as anything else.

In one good-sized plant that is exceptionally well managed, the routine duties of every member of the plant engineering department are covered in a complete set of instructions. Motor inspectors, for example, are told exactly how to inspect the types of motors used in that plant, what to look for, what to do when any abnormal condition is found, and so forth. The same procedure is followed for many other activities. As

little as possible is left to chance or poor judgment. At the same time, the instructions are frequently revised, and the men are urged to suggest new and better ways of doing the work.

This plan may not be adapted in its entirety to every plant, but the essence of it is commended to the attention of every plant engineer who is dissatisfied with the work of his men.

Rain or Snow and Colder

WITH cold weather just around the corner, at least in the Northern part of the country, it is high time to put the plant heating system in condition to meet the demands that will shortly be placed on it. Defective valves, leaky pipes or fittings, radiators or lines that are too small or improperly placed—these and a score of other conditions may seriously affect the efficiency of any heating system and cause its failure to provide the required evenly-distributed heat.

In particular, attention should be given to those hard-to-heat spots that are to be found in almost every plant. When the health and efficiency of workers are at stake, any expenditure necessary to secure comfortable and healthful working conditions can easily be justified. There is no place in modern plants for makeshift heating devices, which are usually grossly inefficient and may introduce a dangerous fire hazard.

Extensive development of heating equipment during the past few years has made available a wide variety of devices utilizing steam, hot water, or electrical energy for economically heating any place where other provisions are lacking or inadequate.

Studied effort now to insure proper heating of all plant buildings may prevent much dissatisfaction and ill-advised measures later on.

Ratio of Lighting Load to Power Consumption

THERE is sometimes a tendency to take the lighting system in an industrial plant for granted, possibly with the feeling that the power consumed therein is only a small part of the total power consumption. That this view is not justified was demonstrated in a paper presented by H. E. Cook and T. G. Ward at the recent annual convention of the Illuminating Engineering Society, in Philadelphia.

The authors made an exhaustive study of the ratios of lighting load to power consumption in twenty industrial plants in Detroit, Mich., manufacturing widely diversified lines, and varying in size and architecture.

A summary of the data shows that the ratio of light to connected load was 31.5 per cent, and the ratio of light demand to total demand was 39 per cent. Again, the ratio of power to total consumption was 64.3 per cent, whereas the ratio of lighting to total consumption was 35.7 per cent. In other words, the lighting system accounts for more than one-third of the total energy consumed.

This study is interesting from several viewpoints, but one fact seems to stand out prominently: Any device or system that consumes more than one-third of the total power used in a plant is worthy of very careful study and care to make sure that it is installed, operated and maintained in such manner as to utilize that power in the most efficient way.

THE greatest tool which our economic system affords for the establishment of stability is the construction and maintenance work, the improvement and betterment, and general clean-up of plants in preparation for cheaper production and the increased demand of the future.—*President Hoover in his message to the United States Chamber of Commerce, December 5.*

Business as Usual?

THE stock market crash and the ensuing action of President Hoover and industrial leaders have caused everyone to wonder just what is to be the immediate future of industry.

Business frequently is affected by intangibles, such as state of mind and rumor, so that prediction with any assurance of being correct is difficult. That there will be no serious depression, however, is indicated by the failure of leaders to discover anything fundamentally wrong with the economic structure, and their expressed intentions of carrying on as usual.

One thing is certain, that the attention of business men will now be focused on their businesses, and not on stock speculation. This means, probably, careful scrutiny of equipment, methods, and personnel, in the interest of preventing industrial losses. The plant engineering departments will not be excepted.

Here's hoping that nothing in the way of emergency work arises to prevent your having a **Merry Christmas.**

Safeguarding Equipment for Power Transmission

By WILLIAM STANIAR

Chairman of the Advisory Board, Power Transmission Association
Power Transmission Engineer
E. I. du Pont de Nemours & Company and Subsidiaries, Wilmington, Del.

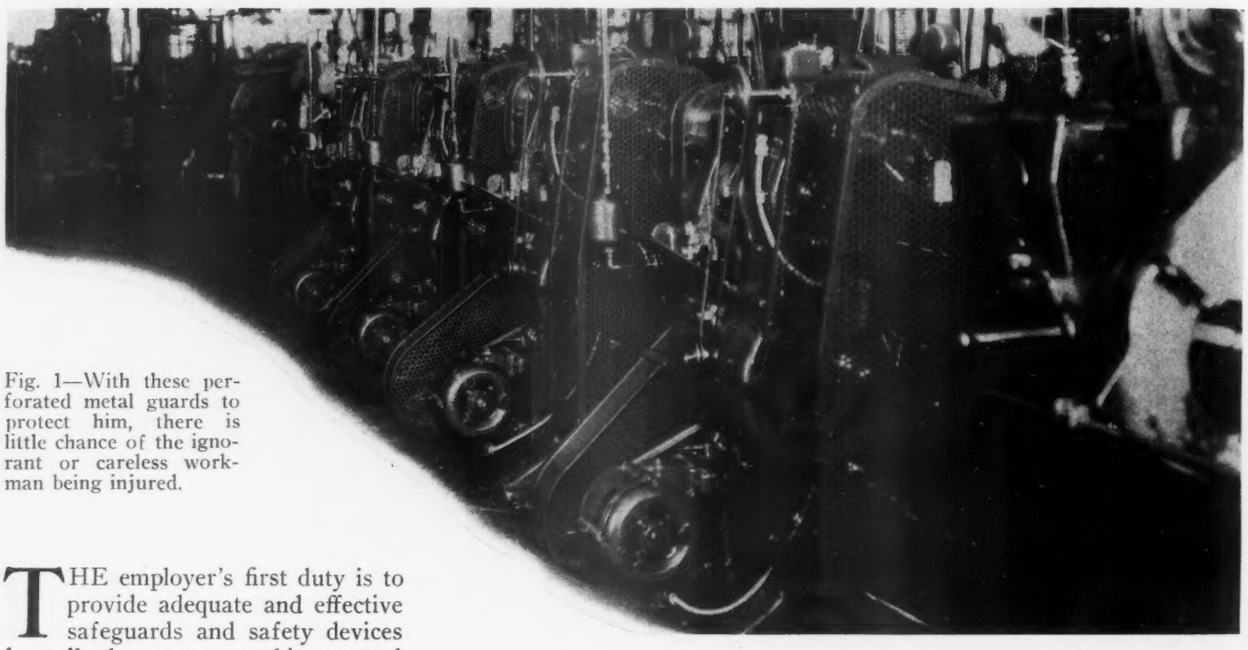


Fig. 1—With these perforated metal guards to protect him, there is little chance of the ignorant or careless workman being injured.

THE employer's first duty is to provide adequate and effective safeguards and safety devices for all dangerous machinery and working places. Machinery should be made foolproof, in so far as possible, to protect the unsuspecting new employee who may become panicky, or through inexperience or ignorance, take unusual chances. The older employee should also be considered for protection, as frequently through familiarity with the operations, he is likely to take unnecessary risks. Failure to maintain safe conditions in a plant results in a loss of efficiency among employees and a loss of loyalty to duty and faithfulness to the employer.

It is logical to install safety devices at the time when general construction work is being done, or alterations of repairs are being made. Results can be accomplished with the minimum of expense and delay at the time plans and specifications are being prepared. In order to make sure that the question of safety will not be overlooked it is well to have all plans, specifications, and drawings checked for safety, making special provision for this in each set of specifications and in the title plate of each drawing.

Electric power is to be preferred to steam from the standpoint of safety, on account of its flexibility and ready adaptability to various methods of control. With motor drives, the momentum of moving parts is relatively small; so the machinery comes to a standstill quickly after power is shut off.

The substitution of individual motor drive for belt drive is always better from a safety standpoint. All switches, fuse boxes, terminals, starting rheostats, motors, and so on should be inclosed or guarded to prevent accidental contact with live parts, irrespective of voltage. The location of controlling devices at points where they can be operated safely, regardless of any failure of the machinery, is essential. Switches should be arranged so that they can be locked in the open position when men work on the line.

A means for quickly disconnecting the power in each room or floor where machinery is used should be provided. This may take the form of an "automatic engine stop" operated with electric push-buttons or a quick closing valve with mechanical tripping device where, steam power is employed; or clutches (preferably of the friction or magnetic type) may be applied to the various lines of shafting.

Machinery exposed to corrosive fumes or substances should be made of corrosion-resisting material, or be suitably protected. The hazard of static electricity from belts, shafting, etc., should be considered where explosive dusts, flammable vapors, or flammable liquids are present. The use of brushes or combs on shafts or belts and the use of a belt-static prevention solution or compound to dispose of static are recommended.

Guards should be designed to meet the conditions. Poorly-constructed, impractical, unsafe guards are far worse than none at all. If guards that are unsafe and in poor condition have been previously installed, they should be torn out and replaced by suitable ones. Guards can be so constructed as not to hamper or interfere with the operation of machines. Guarding should be such that if it is to protect a man from contact it should do this from every possible angle.

The following discussion covers ways of guarding various types of equipment. It must be borne in mind, however, that the standards for the particular state in which the plant is located must be complied with. In most states it is necessary to go farther than the law in safeguarding the workmen, particularly on special devices.

General—Standard guards should be made of expanded metal, perforated, or solid sheet metal, or wire mesh on a frame of angle iron or iron pipe securely fastened to the floor or to the frame of the machine. Illustrations of several methods of guarding are shown in Figs. 1, 2 and 3. Where it is necessary to change belts, make adjustments, or permit lubrication, guards should preferably be provided with hinged sections or be made removable.

The accompanying table covering materials and dimensions of guards was prepared by the American Engineering Standards Committee and is generally recognized as good practice.

STANDARD MATERIALS AND DIMENSIONS FOR MACHINE GUARDS

Material	Clearance from Moving Parts, Inches	Largest Mesh or Opening Allowable, Inches	Minimum Gage (U. S. Standard) or Thickness	Minimum Height of Guard from Floor or Platform Level
Woven wire	Under 4	½	No. 16	6 ft. 0 in.
	4 to 15	2	No. 12	5 ft. 0 in.
Expanded metal	Under 4	½	No. 18	6 ft. 0 in.
	4 to 15	2	No. 13	5 ft. 0 in.
Perforated	Under 4	½	No. 20	6 ft. 0 in.
	4 to 15	2	No. 14	5 ft. 0 in.
Sheet metal	Under 4	....	No. 22	6 ft. 0 in.
	4 to 15	....	No. 22	5 ft. 0 in.
Wood or metal strip crossed	Under 4	½	Wood ¾ in. Metal No. 16	6 ft. 0 in.
	4 to 15	2	Wood ¾ in. Metal No. 16 Wood 34 in.	5 ft. 0 in.
Wood or metal strip not crossed	Under 4	½ width	Metal No. 16	6 ft. 0 in.
	4 to 15	1 width	Wood ¾ in. Metal No. 16	5 ft. 0 in.
Rail	Minimum 15 Maximum 20			

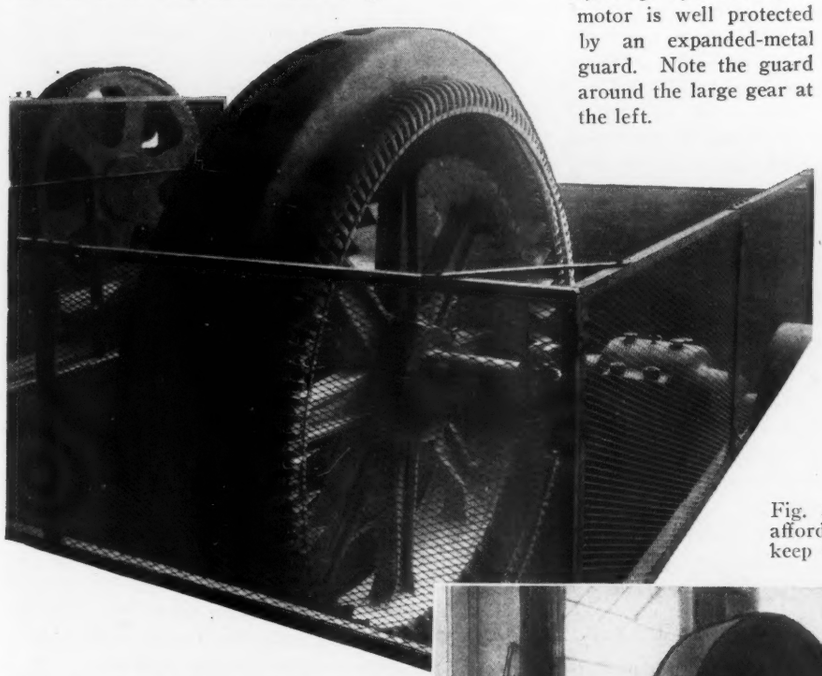


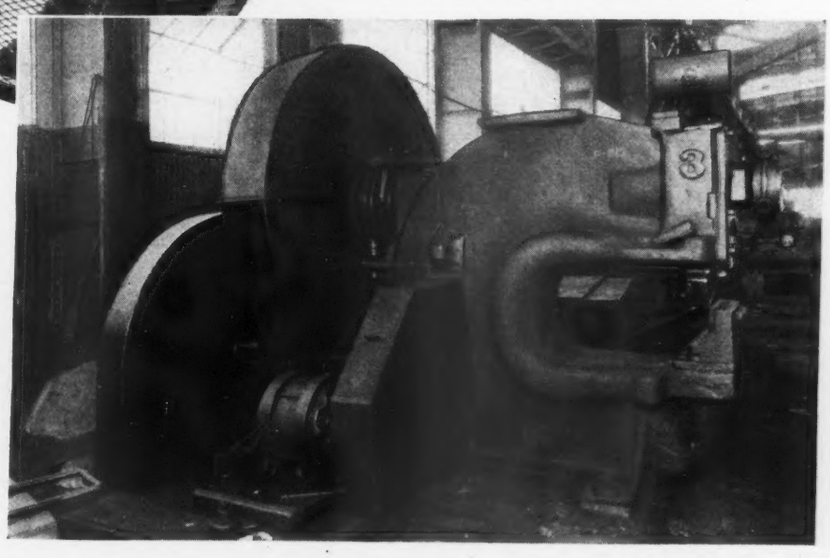
Fig. 2—The pit for this 1,000-hp. synchronous motor is well protected by an expanded-metal guard. Note the guard around the large gear at the left.

If the area of the filler is more than 12 sq. ft., addition frame members should be provided. All joints of framework should be made equivalent in strength to the material of the frame. Fig. 4 illustrates some details in the different methods of making guards.

The planes of rotation of engine flywheels should not be in line with workrooms. Flywheels should be guarded from accidental contact by handrailings 15 in. or more from the moving parts, or by some equivalent means. Toeboards are necessary around flywheel pits.

Shafting—Each continuous line of shafting, including vertical shafting, should be securely held in position

Fig. 3—The solid metal guards on this press afford perfect protection for the workmen and keep dirt and chips out of the gears.



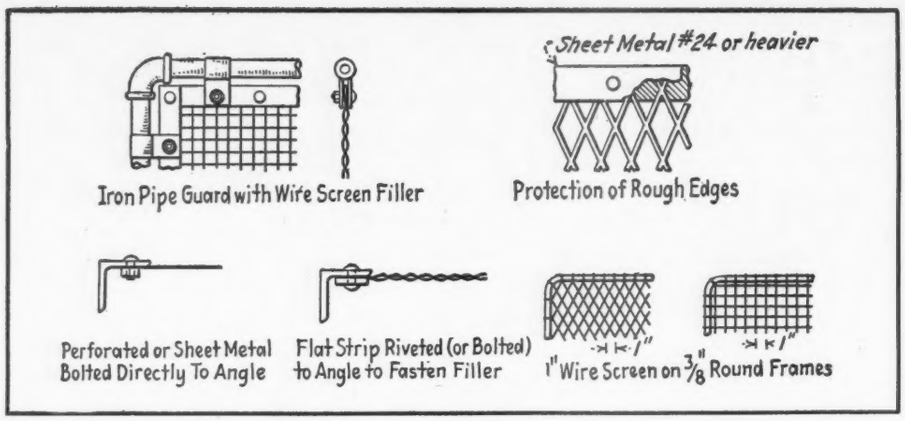

Sheet Metal #24 or heavier
Iron Pipe Guard with Wire Screen Filler
Protection of Rough Edges
Perforated or Sheet Metal Bolted Directly To Angle
Flat Strip Riveted (or Bolted) to Angle to Fasten Filler
1" Wire Screen on 3/8 Round Frames

Fig. 4—Details of construction for fastening expanded metal or screen to the frame of guards.

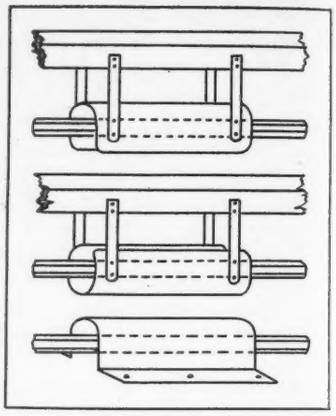


Fig. 5—Three methods of guarding overhead shafting.

against endwise thrust. The shafting, including shafting under benches, should be protected from contact at all working floors or platforms, as shown in Fig. 5. Projecting shaft ends, unused keyways, and projecting setscrews should be eliminated or guarded, regardless of their position.

Pulleys—Overhanging pulleys on line-, jack-, or countershafts with no bearing between the pulley and the outer end of the shaft, should be avoided, but when this is impossible a guide to prevent the belt from running off the pulley should be provided.

Pulleys with cracks or pieces broken out of rims should not be used, and composition pulleys should be avoided, especially where they are subject to moisture. Special design for pulleys is required when the speed exceeds 4,000 f.p. minute.

Belt, Rope and Chain Drives—Guarding of these types of equipment against accidental contact is necessary and the guarding should prevent persons going through large belts unless suitable passages are provided, as shown in Fig. 6.

Overhead belts should be guarded when the belt is 8 in. or more in width, when the distance between centers of pulleys is 10 ft. or more, or when the speed of the belt is more than 1,800 f.p.m. The guard should be continuous in order to prevent a broken belt from catching on the guard and pulling it down.

Cone pulley belts should be guarded and equipped with suitable belt shifters to eliminate the possibility of anyone coming in contact with the moving parts.

Suspended, counterbalanced tighteners should be protected where necessary and some means must be provided to prevent the tightener from doing harm in case the belt breaks.

Gears, Sprockets, and Chains—Any overhead sprocket wheel and chain should be inclosed where there is the least possibility of an injury. Automatic oiling devices, extension oil cups, and suitable openings in guards for oiling, made in such a way that it is impossible for a man to be caught, should be employed as needed to provide a safe means of oiling.

Miscellaneous—The guarding of friction drives, projecting bolts, or setscrews is necessary wherever contact is possible.

Collars and couplings should be so made that there are no projecting ends that might entangle clothing. Bearings should preferably be self-oiling, and drip cups and pans should be securely held in place.

Portable ladders are to be avoided in favor of permanent ladders and walkways.

Installation of permanent belt shifters on all tight and loose pulleys is good practice. All belt and clutch shifters of the same type should, if possible, move in the same direction to stop machines. The use of belt poles as substitutes for mechanical shifters is not recommended. Where loose pulleys or idlers are not practicable, belt perches (Fig. 7) should be used to keep the belt away from the shaft.

Testing of cast-iron pulleys with a hammer, to disclose cracks and making sure that the bolts holding the sections of a split pulley are tight, and that setscrews, etc., have not worked loose, are other points that should be checked over.

When belt dressing is necessary, the application should be made when the belt is stationary; if this is impossible, the dressing should be applied on the belts where they leave the pulleys. The same practice also applies in lubricating chains.

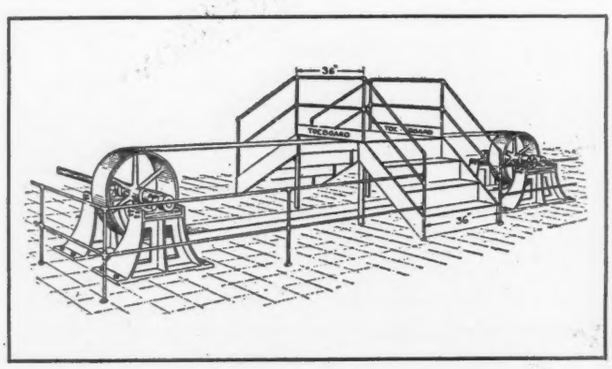


Fig. 6—Here is a good method of providing a passageway over a belt.

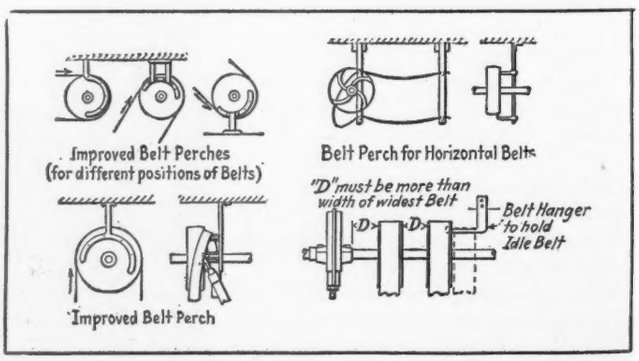

Improved Belt Perches
(for different positions of Belts)
Belt Perch for Horizontal Belts
"D" must be more than width of widest Belt
D
D
Belt Hanger to hold Idle Belt
Improved Belt Perch

Fig. 7—Properly-designed belt perches play an important part in safety.

Are You Ready for the Question?

A forum for the discussion of subjects in plant engineering

Here is the sixth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to this month's question also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

WHO SHOULD DO THE SALVAGING?

Frank Fulleger and George Shipman, who introduce questions in this forum, are now making their sixth appearance. Many of INDUSTRIAL ENGINEERING'S *readers have taken active part in discussing the questions. Doubtless many others are following the discussions with interest and profit. This group might just as well join forces with the active group. Its members will feel that they are really in the game when they see their signed statements in print.*

* * * *

"Pretty good show so far, Frank," said George Shipman, as the two men were having a short smoke between the acts; "but this author has gotten the characters into such a fix that I don't believe he himself knows how to straighten things out."

"Yeh! and I'm in about as bad a fix as the author," broke in Frank Fulleger. "Of course the boss would pick the day I had tickets for the theatre to tell me to clean out the 'junk' in the available and obsolete equipment yard."

"That's easy," offered George. "All you have to do is put your gang on it for a few days and it's done."

"But, George, how about the regular work that must go on as usual? Besides, all that equipment isn't scrap and it takes a lot of my time, all at once, to decide what to throw out and what to hold."

"Why don't you make some arrangement for dispersing each piece as it is brought down to the yard?" suggested George.

"That's just what I have been thinking of," said Frank; "but there are certain things that must be given consideration: *Who is to decide whether to hold the equipment intact or dismantle it? Should the maintenance men or a special salvage department dismantle the equipment? Should the salvaged parts which are standard and in good repair be put into regular stock or kept in a separate place?*

"I have been thinking these things over today and have about decided that the disposition of available shop equipment is so important that ——"

"Come on, Frank. Snap out of it. There's the bell for the next act," broke in George, as he tossed away his cigarette and started for his seat.

* * * *

So here we are again. Just when we were prepared to hear Frank's conclusions, the curtain goes up. At any rate we have the questions. Some of you readers of INDUSTRIAL ENGINEERING *have already solved them satis-*

factorily. By sending in a short discussion on how available and obsolete equipment may best be handled, you may help a brother engineer out of his difficulty. And despite what you have done, you may get some ideas that will improve your methods. Let the editor have your discussions within the next three weeks. Remember, you are discussing the questions raised by Frank; they are printed in italics as a part of the "act."

Readers' answers to previous questions

Who Shall Do the Oiling?

(Question Presented in the November Issue)

OILING now is not a definite responsibility of anyone—in too many plants.

Oiling requires special technical knowledge concerning plant equipment and lubricating materials. It seems logical that the supervision of oiling should go to the men who have the best insight into any given equipment. These men have the privilege of calling on the sales engineers of the lubricant maker and can use the knowledge so gained to insure that the materials and methods are correct. If the supervision has an intimate contact with the equipment and knows why each machine fails or wears, then he is competent to direct the personnel whose duty it is to supply the lubricant in the correct dosage and specified grade. The statements just made are purposely general because each plant is a problem in itself, but the fundamentals hold true in all applications.

To be more specific, the method as applied in a large industrial plant may be of interest. About 1,200 motors, aggregating 25,000 hp., were driving pumps, conveyors and heavy geared machinery, embracing all types of gearing. Lubricating conditions were severe, due to a wide range of temperature in the process and abrasives were present around 30 per cent of all drives. The responsibility was divided two ways in connection with oiling. The electrical department was responsible for oiling all electrical equipment. The mechanical department was responsible for oiling all mechanical equipment.

The oilers operated from a central oil house over a definite route each day scheduled so as to reach each bearing at the proper interval of time whether daily, monthly, or longer. The number of oilers has been gradually reduced over a term of years by several means. One important device is the pressure fitting for grease bearings. The old individual grease cup was a great time consumer as well as a waster of grease. Each cup required as much time to fill as a pressure gun containing one pound of grease. Antifriction bearings with effective seals have saved a large amount of lubricant. Better construction of the seals on sleeve-bearing motors has saved much oil and reduced the number of visits of the oiler.

Team work is essential in oiling as in all phases of plant activities. The engineering department can keep a close check on designs and adapt new devices to old machines. For instance, the life of several silent-chain drives formerly was one year. We don't know how long a chain will last now as the new method of oiling has been in effect only five years! This result was obtained by the use of a drop feed oil cup, feeding about 10 drops of oil per minute to the lower inside of the chain by means of a piece of ⅜-in. pipe extending into the main housing.

Another form of co-operation of departments is exemplified by a case where the motor testing crew found a 10-hp. d.c. motor driving a worm-gear hoist somewhat overloaded. The motor seemed to be slightly out of line. It was realigned with no change in the load conditions. The machine was opened up and the gear was found nearly dry. The friction had increased the load. The gear compound was brought to the proper level and the load on the motor dropped to normal. The oiling of such machines, which may be used infrequently and likewise require oil at infrequent intervals, needs the attention of engineers, operators, repair men and testers. Leaks, evaporation, and defective or inefficient oil level indicating devices may cause serious losses and even operating failures of equipment.

ELMER HOUSLEY, *Electrical Superintendent Aluminum Company of America, Alcoa, Tenn.*

LUBRICATION in the progressive industry of today is looked upon in a new light. There was a time when it was considered as just a routine job which had to be done; practically no thought was given to its supervision, and research and development in this field were unheard of. Today there is a different picture. Development of and education in the merits of proper lubrication have been rapid, as is quite well realized by most plant executives and engineers. The problem is to co-ordinate these factors so that they will be most effective in economy and elimination of waste—not only in the lubricants used, but in production, men, and overhead.

Where size of plant and equipment warrant it, oiling and lubrication in general should be carried out separately from production work; that is, preferably under the plant engineering or maintenance department, for lubrication has a direct and very important bearing upon the life and satisfactory operation of equipment. In many industries the services of a quali-

fied lubrication engineer to supervise this work have been found indispensable. In smaller concerns, where this procedure would not pay, there are available the services of lubrication engineering organizations sponsored by the oil companies. These organizations survey all plant equipment and recommend the proper oils and greases to be used. Even in establishments that have efficient departments doing the work, it often proves advisable to have one come in from the outside for an unbiased survey—thus gaining new ideas acquired through broad, practical experience as well as scientific research.

There is, of course, some special equipment that is not always best allotted to the regular oiling crew, although it should be under the same general supervision whenever practical. Equipment requiring a special knowledge of its working and requirements come under this head, such as hydraulic pumps, air compressors, accumulators, refrigeration machines, electric equipment (other than motors), etc. For this reason many machine shops also find it advisable to have the regular oiling crew take care of all transmission up to the machines, leaving the responsibility for the latter to the foremen in charge. Where production piecework is involved it has been proved over and over that lubrication should not be left to the operator unless special arrangements have been made for regular lubricating periods.

It is just as important, although not always so recognized, to keep abreast of developments in this as in other fields, if highest efficiency and low ultimate costs are to be expected. Oilers should be equipped with suitable trucks and handling facilities. Sight-feed oilers, drainage and return systems, and grease gun units are now offered to meet almost all conditions. There are on the market automatic and semi-automatic central station lubrication systems that will meet the most exacting conditions. Not only are these units safe, eliminating all hazards so common in many instances where machinery is of a complicated nature or where extreme temperatures or dangerous fumes are present, but they also often reduce the size of the oiling crew. There is here, too, practically no loss of production time, while the amount of lubricant required is often cut from 25 to 75 per cent.

Prevention of waste is an item of no small importance. Oil filtering units will often prove very profitable. Thus a high-grade motor oil may be filtered after its useful life as a motor oil and used over on general transmission bearings and others. Oil waste and rags, if used indiscriminately, will run into many dollars in the course of a month in the plant of average size. The proper grease applied to the piston of a hydraulic pump or accumulator often will postpone overhauling for several months. These, of course, are only a few of the items which vary with conditions that must be watched and can be guarded against only when under close supervision of one well versed in this work.

Where the lubricating problem is given the same serious consideration that is devoted to supervision and follow up, the undertaking is well rewarded. Following are listed some of the more important advantages to be gained when this is properly carried out:

Systematic inspection.

Minimum number of men and elimination of production men for this work.

The proper lubricant for the proper job.

The keeping of a practical record of facts, including analyses and performance of various lubricants.

Budgeting and consequent elimination of waste.

Centralized storage facilities.

HERBERT L. SCHULTZ, *Asst. Supt. of Maintenance*
The Carborundum Company
Niagara Falls, N. Y.

IN my opinion all the oiling, except that in the power house, which is usually considered a separate department, should be under the master mechanic and under the immediate supervision of the operating millwright.

Nowadays almost all of the large machines, in a majority of the factories, are direct-connected to motors, and the smaller machines are grouped in such a way that a number of them can be driven from a single lineshaft operated by a motor. The oiling of these lineshafts should be directly under the supervision of the operating millwright.

All the machine operators should oil their own machines; that is, they should keep the oil and grease cups filled. The mechanical department should determine how many drops per minute the different journals should receive. All that most machine operators know about lubrication is that the machines need oil and they will have all oilers feeding the same amount no matter whether the journals make 100 or 1,000 r. p. m. Consequently, they will waste about 50 per cent of the oil.

All of the motor oiling should be done by the electrical department, which keeps a record of the motors and knows when oil should be added or changed. Besides, motor oil is more expensive and it should not be mixed with the other lubricants.

Wherever possible, cup grease should be used. It can be used on practically all shafting and on most of the slower-moving parts of the machines. With modern grease cup systems, bearings of medium speed will need attention about once a month, high-speed bearings about once a week.

While the oiler's job is not nearly so dirty as it once was, still I am afraid that George's man will get a few grease spots on his white trousers if he insists upon wearing them while he is oiling, especially if he should run against a hot bearing, one of which still shows up occasionally.

M. B. KRAMER, *Chief Engineer*
El Paso Milling Company, Ltd.
El Paso, Texas

THERE was a time when the lubrication of industrial machinery was looked upon merely as an obscure matter of routine and of very little importance. With this idea prevailing, it was a common occurrence to see a man put on an oiling job when he was considered as being unfit for any other type of work. But oiling during the last few years has begun to come into its own, until in some plants it is today

keeping pace with the progress of the equipment which it is designed to protect.

Certainly oiling should be done by a workman with at least the average intelligence of the body of workers. The reason for this is that there are many chances for the conservation of oil; saving on wear and tear of equipment; and preventing interruption to production which, we know, is bound to occur when oiling is done in slip-slod fashion by a workman who is interested only in the distribution of five or ten gallons of oil. This distribution may include the floors, stairways and ladders. I once read a story which depicted an aged employee who had climbed a ladder for a number of years to oil the center hole in the end of a shaft.

As to who shall do the oiling: I believe that on some types of machines, when he can do so without interfering with his regular line of work, the operator should do his own oiling. Labor will be saved, and more than likely so will oil, because the operator is held responsible for the cleanliness of the machine and will hesitate to spill or splash oil about as freely as might one who does not have to do the cleaning.

Plants of different sizes will have a variety of lubricating problems. A lubricating gang of from one man up can be used to advantage, because there will be auxiliary equipment to be oiled. Electrical equipment should be oiled by the electrical crew under the direct supervision of the electrical superintendent.

As for the oiler's job: Most assuredly it is being elevated. Surely with the new and automatic lubricating systems in use today the oiler has less drudgery to perform, and a higher type of skill is attracted. The oiler realizes that he is performing an important part in the plant's operation, requires less supervision, and is more interested in the conservation and distribution of his grease and oils.

Where there is a lubricating gang, one member should be recognized as leader and given a little more pay. He will keep track of the work and see that the lubricants are intelligently distributed. When such a gang is functioning it should come under the direct supervision of the master mechanic, plant engineer, or whoever happens to be held responsible for the maintenance and upkeep of the equipment, to whose advantage it is to see that the oiling is done efficiently and economically.

It is my contention that more money should be paid for the oiling jobs of today in the interests of maintenance. A plant oiler could be trained and developed into an indispensable machinery inspector, if the job were viewed from the right angle. We see the millwright walking around mornings on a kind of inspection. He glances here and there and misses a number of impending distress signals. Then comes the oiler who, from the nature of his work, has a chance to view the equipment from all angles. Who is in a better position to report a loose foundation bolt, a wobbly lineshaft, a belt not running true on the pulleys, excessive vibration in some pieces of equipment, a worn bearing, or a multitude of other such items?

MARIN PHILLIPS, *Electrical Superintendent*
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Niagara Falls, N. Y.

Who Shall Do the Welding?

(Question Presented in the September Issue)

THIS question immediately suggests to our minds the question, "What Welding?" That is to say, Is the welding part of the process of production of the product that is to be sold, or is it strictly such welding as may be found necessary in the maintenance and operation of the plant?

There are two types of welding so far as production is concerned; namely, the repair of minor defects in castings, and the welding such as would be found necessary in fabricating sheet metal or other products into the size or form necessary in producing the product that is sold.

Welding, therefore, as a general term, covers a wide field of effort, and if the welding required by the production department is of any quantity while that required by the maintenance department is comparatively small, it would probably be the wisest procedure to have the welding department as a part of the productive element of the shop. All repair welding would be delivered to this department with the proper order forms so that the labor and material required to make the repair would be properly charged.

There are, however, many plants in which the welding organization is a part of the maintenance department and is recognized as a non-productive expense. In this case all work of a productive character is delivered to the welding department with the necessary order forms, numbers, etc., so that the labor and material are charged to the correct production order.

It is, therefore, usually a matter of managerial policy to determine whether the welding shall be done in a welding department classified in the plant engineer's department or whether it shall be classified in the production superintendent's department. In either case the welding has to be done and the sole reason for the maintenance of a welding department is to serve the shop at the lowest cost consistent with quality.

Skill in welding is a necessary element and is the result of experience with various kinds of work coupled with a thorough application of one's mind to the study of all problems presented. Skill plays a much more important part in the production of a good finished welding job than it does in the case of machine shop practice. There are many types of welding jobs that cannot be satisfactorily undertaken by a man lacking experience.

Many jobs, from a welding standpoint, are possible, but so far as the finished job is concerned welding might not be practical. For instance, a section might be broken out of the rim of a gear wheel between two adjacent spokes. It is quite possible to weld this broken section back to the gear, but the pitch line of the gear teeth after welding would not be true, and the gear would not be a reliable one in service.

From several years' experience in plant maintenance work it is my opinion that reliable welders can be made to suit any shop requirements or conditions by choosing a good type of workman who has a desire to learn and to master welding. An abundance of instruction is available from the manufacturers of welding equip-

ment and supplies, and it is possible to send such men to welding schools which are maintained by the manufacturers of electric and gas welding equipment, and welding supplies. In these schools the men will receive the very highest grade instruction that it is possible to acquire.

HARRY W. BENTON, *Plant Engineer*
Pratt & Whitney Company, Hartford, Conn.
Member Board of Advisory Engineers
Power Transmission Association

THE question of who shall do the welding, a man on the regular maintenance force or an outside contract shop, is a part of the larger policy in regard to all maintenance work, but one on which I have pretty strong convictions.

It is not particularly hard for a man of average intelligence who will take an interest in the work to learn to be a good welder, but to develop him to the point where his work can be depended upon every time will probably involve enough delays in production, due to the failure of faulty welds in repaired machine parts, to make the cost of his education equal to that of a college professor's.

Almost as important as experience is practice; so, unless there is a fairly good volume of work, either on repairing alone or manufacturing combined with repairing, it is wiser to send the work to some good contract shop. In the more difficult jobs, those involving heavy sections or spidery pieces which will be broken by unequal expansion, so much depends on proper preheating and cooling that it is difficult for the man who gets only one of these occasionally to judge what he should do.

In mines or outlying plants, where no outside facilities are available, the situation must be accepted and a man trained.

Even when a welder is employed there are situations where outside help must be called in, for instance when a portable electric welding outfit must be used or thermit welds on very large steel parts must be made.

H. D. FISHER, *Plant Engineer*
New Haven Pulp & Board Company
New Haven, Conn.

IT all depends upon the type of plant. In a chemical plant or oil refinery, where there is a great deal of piping and tank work, there is no doubt that a staff of competent welders should be kept all the time, because great savings can be made in making up pipe joints and connections. Take an opposite extreme, such as a rock plant, it would hardly pay to carry a man who is a welder and nothing else. In a plant where this condition exists it pays to call in a welder or send the work out.

In some plants a machinist or mechanic who can handle a torch efficiently should be on hand for the odd piece of simple, straightforward work that does not have to stand high pressure or any extraordinary stress. Only efficient operators who have been tested thoroughly, especially in regard to work on pressure vessels, should be employed on this class of work.

If the plant is big enough, and of the type to use welding, do it all at home.

If the plant is small, and only the occasional job comes up, unless there is a competent welder in the organization send it out rather than let the amateur "sling metal" on it.

To make a first class welder, the man must go a little into the theory of the work to understand the reaction set up in the metal by the application of heat. He must learn how to control these reactions and must develop an unerring judgment in the selection of the size of rods, welding tips and so forth.

For a man (preferably a young one) with average education, welding is not hard to learn. Experience, coupled with aptitude, is the keynote to a good weld.

It is evident in steam lines and pressure work that welding is dependent on the human element, and in building up a welding organization too much care can not be taken in picking the men. As an example, at the present time I am interested in the construction of a compressor plant where the maximum pressure is 1,000 lb. per sq. in. We are experiencing difficulty in getting real welders on this work and have probably tried out twenty-five under the eyes of a foreman.

Some organizations pay their welders enough to justify requiring them to own their own equipment, which is not a bad plan.

It pays the employer to pay his welders a good rate, and get the best men; then he can expect the best results. Some firms make a point of paying as little as possible and the results obtained are what would be expected.

M. C. COCKSHOTT, *Mechanical Engineer*
Hancock Oil Company
Long Beach, Calif.

Who Shall Do the Cleaning?

(Question Presented in the August Issue)

WHETHER plant cleaning should be done by each department or by a special crew depends largely upon the size of the plant, the number of departments, and the number of men employed. If a plant is large enough to maintain a permanent clean-up crew, such a crew is advisable in more ways than one. This crew should be under the direction of a man with considerable mechanical ability, and the duties of the crew need not stop at cleaning, although this is the primary reason for its existence.

When headed by such a man, the duties of the crew may cover such items as inspection of buildings and keeping records of the condition of floors, ordinary and fire doors, windows, elevator gates, ladders, stairways, roofs and roof drains, etc.; cleaning of reflectors and lamps, motors and control equipment, with the exception of high voltage equipment; cleaning of pipes where rust has accumulated, and reporting on their condition. The man in charge could, on his daily rounds, thus act in the capacity of a safety engineer.

In a smaller plant, however, it is doubtful if the expense of maintaining such a crew is warranted, and in such a case each department should be responsible for its own cleaning.

Millwrights, electricians, pipe fitters, and other high-class mechanics do not look with favor on cleaning up

after their work is done, although where these men are supplied with helpers it is the helpers' duty to clean up, and the mechanics' duty to see that it is done. In the absence of helpers it is hardly right to ask the mechanics to perform this duty, as it not only makes a mechanic a disgruntled individual but also costs the difference between the wages of a high-priced and a low-priced man. In such a case the lower-paid men of the department should clean up.

In most departments there are men responsible for the moving of the manufactured products and, while these men are part of the production crew, the nature of their work does not interfere with keeping their departments clean. In the event of a breakdown these men are often called to assist the mechanics, and since they know that their jobs depend upon clean products they have no hesitancy in cleaning up before the plant starts operating again.

I say that Frank is headed in the right direction, and as a suggestion mention that if a handy man of proved ability is given charge of all cleaning, and his position dignified with some appellation other than that of chief scavenger, and he is allowed to pick and place his men where they will do the most good, and those men are not interfered with by department foremen, there is no reason why the work of cleaning and inspection cannot be done with dispatch and at a greater saving than when done by the haphazard methods usually employed.

H. E. STAFFORD, *Electrical Engineer*
Port Arthur, Ont.

WHO should do the cleaning depends in a large measure upon the size of the plant and the work carried on. If the plant is large enough to keep a general cleaning crew such a crew should be maintained for several reasons.

It is not good policy to ask the maintenance gang in small or large plants to clean up after an overhauling; a great deal of such work is done on overtime and is usually rush. The maintenance gang is tired when the job is completed and does not feel like cleaning up. Also it is costly having skilled men do such work.

The best way to get such cleaning done in the smaller plant that cannot maintain a general cleaning crew is to teach the new people coming into the plants, nowadays usually boys out of high school or college, that whether as helpers in the maintenance gang or at any other lower grade of work in other departments it is part of the scheme of things to do cleaning when required, and which they will not be required to do when they advance to a better grade of work. The helpers on an overhauling job should do the cleaning; if no helpers are employed on the job a gang should be recruited from the beginners in various departments and, in charge of a competent man, clean up before the production workers arrive. It usually spoils the day for the production worker to find his place mussed up and dirty.

Skilled workers or production workers that have advanced to a better grade of work should not at any time be asked to do clean-up work. To ask such a worker to do this kind of work affects his pride and seriously interferes with the program of progression lined up by the company. It is presumed in this discussion that we are speaking of modern plants that have inaugurated programs of continuous advancement.

MAURICE PETERSON, *Plant Department*
Western Electric Company
Emeryville, Calif.

Should the Plant Engineering Department Have the Right to Question Orders?

(Question Presented in the July Issue)

Whenever any equipment is to be moved, nothing will be more productive of smooth progress than close co-operation between all those affected. It should be the privilege of both department head and plant engineer each to question the decisions of the other; questions which cannot be settled by mutual agreement to be decided by the works manager.

The average department head is interested mainly in high production records for his department. But, in securing this high production, he may decrease production for the entire plant, or his layout may interfere with the efficient operation of another department. He may lose sight of the fact that the sequence of operations, though of great importance in plant layout, is not the only factor requiring consideration.

Ordinarily, it is best that the lanes of travel do not cross, though there are times when it is advisable. For instance, an operation in the middle of the production line may considerably slow up the balance of the line due to inadequate lighting facilities for that operation. In a case of this kind, the operation should be taken out of the line. This may result in increased cost of material handling, but the increased production or improved quality of the work, due to better lighting conditions, may more than offset this added expense.

As the plant engineer is in closer touch with the works manager than the department heads, he will usually know more of the management's future plans. Though the department head may have the best conception of present requirements, the plant engineer may know that a move for the betterment of present conditions may result in considerable relocating of equipment in the near future. In many cases, a slight inconvenience for a short space of time will result in a future saving.

In locating equipment, the safe working load on the floors and the factors of power transmission and interdepartmental transportation of material must be considered. As these subjects are within the domain of the plant engineer, it is but natural that he would be more familiar with them, and more capable of rendering an intelligent decision.

I believe that the best plan is to give neither the plant engineer nor the department heads absolute authority on the question of moving equipment. A plan, mutually agreed upon by both parties, should be submitted to the works manager for final approval.

R. H. KASPER, *Master Mechanic*
Steel Heddle Manufacturing Company
Philadelphia, Pa.

MODERNIZING OLD MOTOR WINDINGS

How to replace an old Bar and End Connector Winding by the diamond, two-layer type

By A. C. ROE

Renewal Parts Engineering Dept. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

THE type of winding described in this article was extensively used in the early types of motors and generators. The winding consisted of copper bars in the slot section, with the ends connected together by involute-shaped connectors, on each end. Hence the name Bar and End Connector Winding.

This winding was used for stators and rotors in a number of different forms, the main disadvantage being the large number of soldered joints to be insulated, and the number of expensive end connectors.

In Fig. 1 is shown a two bar per slot, bar and involute end connector type of winding.

A rotor with a one bar per slot end connector winding is shown in Fig. 2. The bars are all of one length and staggered in and out, in alternate slots.

A one bar per slot winding, long and short bars, with a number of special end connectors is shown in Fig. 3.

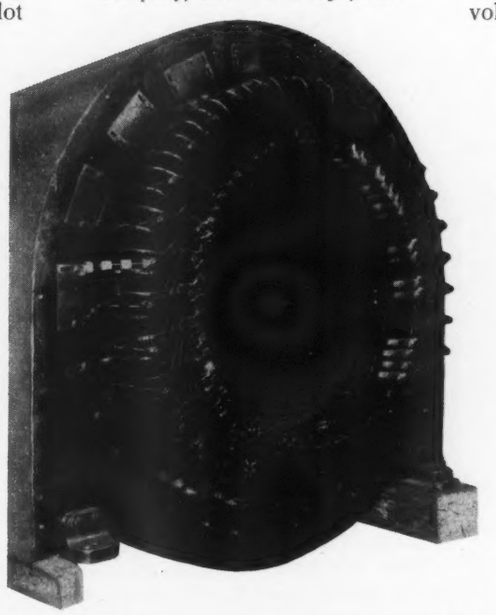


Fig. 1—Two bar per slot, bar and involute end connector winding with long and short bars.

When considering the possibility of changing any type of this winding to a two-layer winding, it should be borne in mind that for 2,200 volts and above the iron should be changed to punchings having open slots, or a shoved-through winding used. For the lower voltages, the threaded-in, wire-wound (round, square, or ribbon) two-layer coil type can be used. The new winding should have a large number of turns per coil, and be connected in as many parallels as the coils per group and number of poles will permit. The following example will bring out these and other points that must be checked before deciding for or against any changeover.

The machine under consideration was a 300-kw., two-phase, 14-pole, 480-r.p.m., 440-volt, 340-amp., 56-cycle, rotating-field generator, and the problem was to reconnect or rewind it for 220-volt, three-phase operation. If rewinding was necessary the customer wanted an up-to-date,

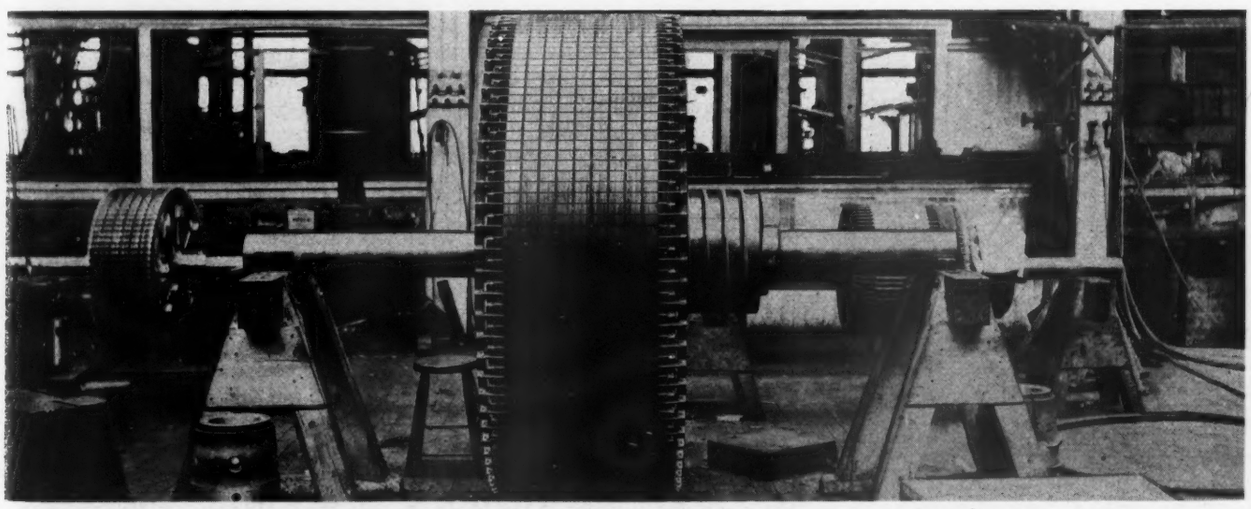


Fig. 2—One bar per slot, bar and end connector winding with all bars of the same length and staggered.

two-layer winding, using the same old iron.

The stator had a bar and end connector, one bar per slot, closed circuit, wave winding tapped at four points for two-phase operation. The winding is shown in Fig. 4, and the table gives the 23 series of coils or 14 slots that had to be passed through before the winding closed on itself.

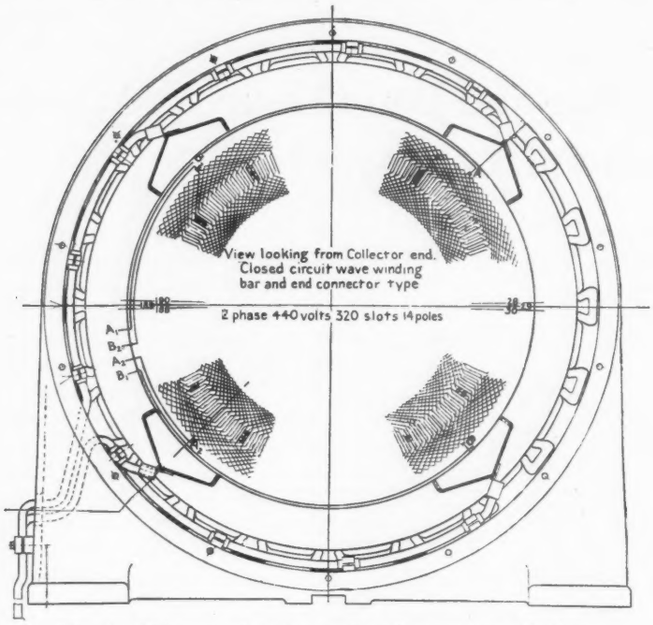


Fig. 4—Old, two-phase bar and end connector winding.

Study of the table and Fig. 4 will show that, starting at the *A1* lead there are two circuits, one to the left or counter-clockwise from bar *1* to *24, 47, 70, 93* and ending at bar *138* after passing 11 3/7 times around the stator, making a total of 80 coils or 168 slots. The second circuit starts on bar *298*, advances to the right, or clockwise, to bars *275, 252, 229, 206*, and so on, ending at bar *161* at the *A2* lead after passing around the winding 11 3/7 times, or through 80 coils and 160 slots.

The B phase also has two paths, starting at bars *81* and *58* and ending at the *B2* leads at bars *241* and *218*. Thus each phase has two parallel circuits of 40 coils per circuit.

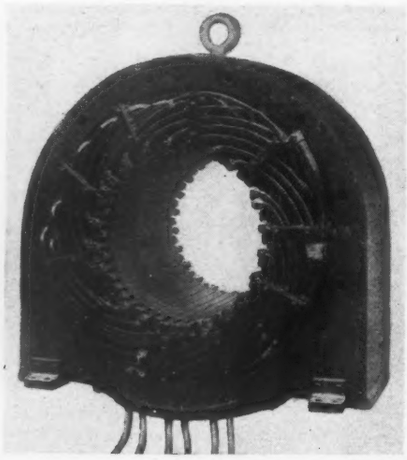


Fig. 3—Bar and end connector, one bar per slot, winding with S-bend end connectors.

As this is a closed-circuit, two-phase winding of the two-circuit type, there are only two taps for each phase, or the winding is divided as shown in Fig. 5, where legs *1* and *3* are the A phase and the line voltage E is equal to volts per leg $\times \sqrt{2}$; thus, the current per line divides into two paths, or with 320 slots and 160 one-turn coils, each leg would have 80 slots and 40 coils or turns.

From Fig. 5 it is apparent that the voltage per leg, *1, 2, 3,* or *4,* is $440 \div 1.414$, or 311 volts. Then with 40 turns per leg, the volts per turn equal $311 \div 40 = 7.8$, approximately. To change the present closed, two-circuit winding to three phase, the connection would have to be as shown in Fig. 6. With 320 slots and 160 coils, each leg would have $160 \div 6$, or 26-27, 27-26, 27-27 coils, and with 7.8 volts per turn, the voltage per leg would be $26 \times 7.8 = 203$, and $203 \times 1.732 = 352$, the line voltage.

The winding in Fig. 6 is divided into six sections, and the two sections of each phase could be paralleled. The line voltage would be the same as the voltage per section, or 203. Thus, one connection gives a voltage that is too high, whereas the other is too low.

It is obvious that 320 slots are not divisible by 3, or by 42; hence, a balanced three-phase winding is impossible. Therefore, only 318 coils and slots can be used for the new 220-volt, three-phase winding, as $318 \div 3 = 106$ coils per phase.

In figuring the number of turns per phase for the new winding, we can use the value of 7.8 volts per turn; then for a series-star connection the volts per phase, with a line voltage of 220, will be $220 \div 1.732 = 127$ volts.

The turns per phase for 127 volts will be 16, for a series connection, 32 turns for a two-parallel connection, 112 turns for a seven-parallel connection, and 224 turns for a fourteen-parallel connection. But with 106 coils per phase we can have only 106 turns, or 224 turns per phase.

Trying the delta conection, it requires 73 per cent more turns than

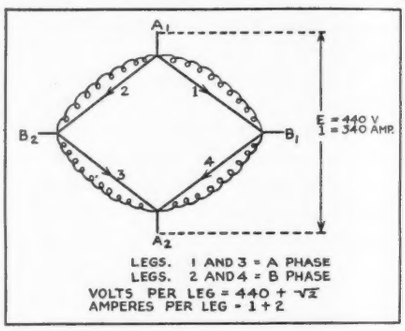


Fig. 5—Closed-circuit, two-phase, two-circuit, wave winding having four sections or legs.

* * * *

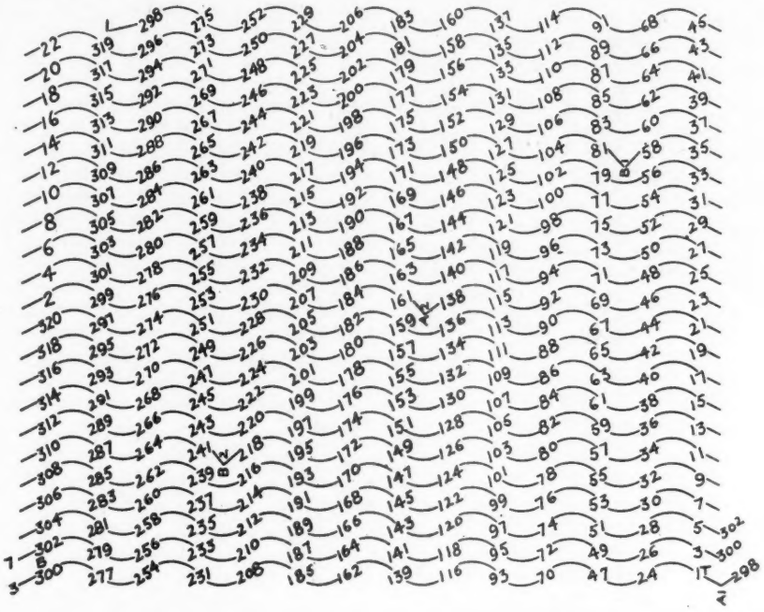
the star connection, or the volts per phase are the same as the line voltage, 220. With 7.8 volts per turn, the turns per phase for a series-delta connection are $220 \div 7.8 = 28$, or 56 turns for a two-parallel connection, 196 turns for a seven-parallel connection, and 392 turns for the fourteen-parallel connection.

A large number of turns of a small-size wire are required; therefore, the fourteen-parallel delta connection was adopted. Then 392 turns per phase and 106 coils mean that there should be $392 \div 106 = 3.7$ turns per coil, but a four-turn coil will be used to carry out the problem, making a total of 424 turns per phase, which can be reduced somewhat by a chorded coil pitch.

The next step was to figure the wire size for the 220-volt, three-phase winding, with a line current of 680 amp. With a delta connection the current per phase will be $782 \div 1.732 = 451.5$ amp. With a fourteen-

Series of Coils and Slots Passed Through Before Old, Two-Phase Winding Closed

The series of slots shows the front and back connector pitches. Each horizontal line of figures represents the series of bars and end connectors that encircle the winding once. For example, starting at slot *1* the first series passes across the back to slot *24*, then across the front to bar *47*, across the rear to bar *70*, and so on, until the series of seven coils and fourteen slots ends up on bar *3*. The second series starts here, as shown in the second line. See Fig. 4 for the connection diagram of this winding.



parallel connection, the current per circuit or parallel leg will be 451.5 ÷ 14 = 32.25 amp. per coil.

The two-phase winding had 170 amp. per leg, and each conductor consisted of a ⅛ × 1⅜-in. bar (0.16758 sq. in.). Hence, there were 0.16758 ÷ 170 = 0.000986 amp. per sq. in. for the two-phase winding.

For 32.25 amp. and 0.000986 amp. per sq. in. the area of the conductor should be 32.25 × 0.000986 = 0.0318 sq. in., which is equivalent to a No. 4 (0.204 in.) round wire. With a top slot opening of ⅛ in. the conductor must be stranded and each insulated strand less than 0.115 in. diameter.

It was then necessary to determine the slot space for the wires per coil. Fig. 7 shows the slot size and winding insulation. Depthwise there was a total of 0.046 + 0.0625 + 0.090 + 0.0312 = 0.2297 in., which leaves 1.625 — 0.2297 = 1.3953 in.; or 1.3953 ÷ 2 = 0.69765 in. for each coil. Thus, a four-turn coil must fit in a space 0.309 in. wide by 0.69765 in. deep.

The indications were that a ribbon wire was wanted; this ribbon must not exceed 0.103 in. thick insulated and 0.69765 ÷ 4 = 0.174 in. deep insulated. Figuring on three ribbon wires in parallel widthwise means that each must have an area of 0.0318 ÷ 3 = 0.0106 sq. in. The insulated size of ribbon wire 0.091 × 0.144 in. (area 0.0125 sq. in.) is 0.103 × 0.163 in. Each coil, therefore, was made of four turns of three such wires in parallel wound on edge.

In checking the coil grouping it was plain that 320 coils could not be used. However, 318 coils would give 106 coils per phase. Then 318 coils and 42 groups would give 24 groups of eight coils in series and eighteen groups with seven coils in series; or each phase would have eight groups of eight coils and six groups of seven coils. Odd grouping cannot be used.

The only alternative was to use

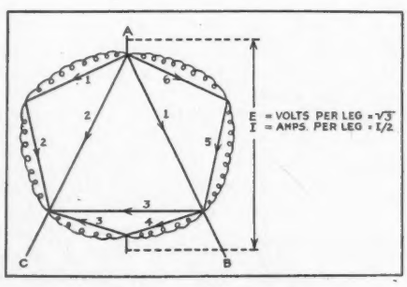


Fig. 6—Closed-circuit, three-phase, two-circuit wave winding having six sections or legs.

three-and four-turn coils to keep the turns in each pole-phase group the same. This also helped to reduce the excess turns, as with 106 four-turn coils there would be 424 turns per phase, whereas only 392 were needed. With seven coils per group and four turns per coil, each seven-coil group would have 28 turns; thus the eight-coil groups should have four coils of three turns each and four coils of four turns, which would give a total of 28 turns.

The coil pitch had to be one that would prevent two three-turn coils coming together in the same slot as the best results would be obtained with seven and eight turns per slot. The two-phase winding had a pitch of 1- and -24 or full pitch, but 1- and -20 would be satisfactory for the three-phase coil, as the four slots under pitch would have very little effect on the voltage, for the electrical

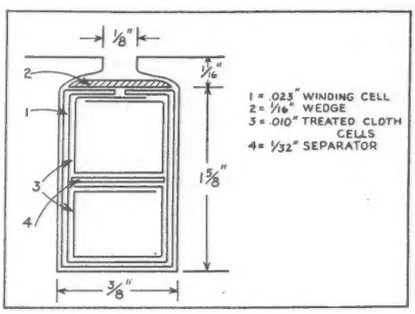


Fig. 7—Slot size and insulation for old, two-phase winding.

* * * *

angle between slots was small. Also, the pitch had to be odd to get a three-turn coil half over or under a four-turn coil half.

The 220-volt, three-phase winding thus had 96 three-turn coils, of three 0.091 × 0.144 d.c.c. ribbon wound on edge and 222 four-turn coils. This means that each phase had 32 three-turn and 74 four-turn coils, or a total of (32 × 3) + (74 × 4)= 392 turns per phase as required to give an average of 3.7 turns per coil.

The wires were threaded in through the opening in the top of the slot, pitch 1- and -20. The coils were connected fourteen-parallel delta, the ends being taped as each coil was installed. The grouping was as follows: 8-8-8-8-8-8-8-8-8-8-7-7-7-8-8-8-7 -7-7-7-7-7-8-8-8-8-8-8-8-8-8-8-7-7-7-8-8 -8-7-7-7-7-7-7.

The coils in such a winding should be installed by starting with a four-turn coil and then putting in a three-turn coil, marking the starting coil

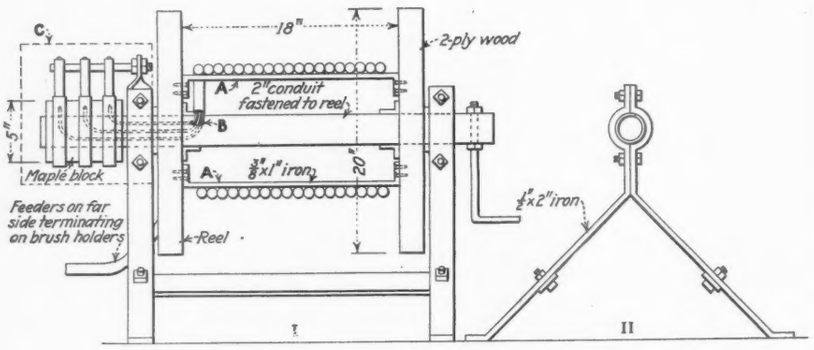
(Please Turn to Page 643)

AROUND THE WORKS

Reel Facilitates Handling of Heavy Cables

ANYONE who has had to drag around a heavy cable feeding an electric shovel or similar machine will find a reel such as shown at I in the illustration to be very convenient. The writer constructed such a reel for emergency use a short time ago and finds that it has more than paid for itself, as slack can be taken up or paid out at any time without shutting down the machine.

As will be seen, the reel itself was constructed of two-ply wood, well nailed, with the grain of the two plies running at right angles. The two sides of the reel were fastened together with six irons, *A*, spaced 60 deg. apart. The axle was made from a piece of 2-in. conduit.



Construction details of reel for handling heavy cable.

The three slip rings were turned out of scrap brass and are 5 in. inside diameter. These three rings are supported on a round maple block 5 in. in diameter. This block was securely fastened to the 2-in. conduit axle. A piece of ½-in. round iron threaded at one end and bent at a right angle was passed through a hole in the other end of the conduit and held in place by a bolt to serve as a handle.

Holes were drilled through the slip-rings, maple block and conduit for the three wires of the cable which enter the axle at *B* through an oblong hole and pass through the axle to the slip rings. The wires were securely soldered to the sliprings and the joint was carefully smoothed down with a fine file.

The reel is mounted on the strap iron supports shown at II. The three brush-holders are Allis-Chalmers No. 5 which are supported by a ½-in. bolt, which is in turn fastened to one of the side supports. A sheet metal cover lined with 1/16-in. fiber covers the current-carrying parts, as shown by the dotted lines at *C*.

I have found that 1,000 ft. of cable can readily be handled on this reel. The cable we use contains three No. 1 conductors and is heavily insulated.

CHARLES A. PETERSON.

Chief Electrician,
Cold Spring Granite Company,
Cold Spring, Minn.

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

* * * *

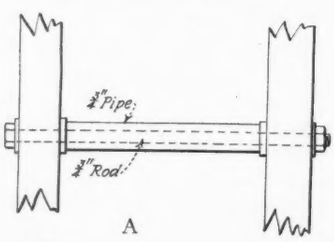
How to Make Sectional Rack for Bar Stock

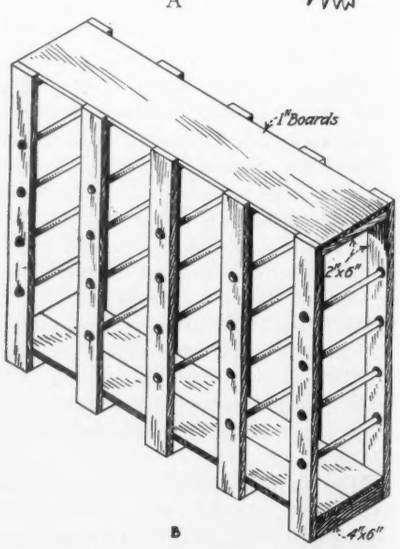
A RACK for bar stock that combines the good points of inexpensive construction and great strength with the decided advantage of permitting the units of which it is composed to be readily re-arranged in any desired manner, is shown in the illustration.

The rack is composed of a number of "ladder" units so constructed as to permit them to be readily aligned and tied together lengthwise by two or more 12-in. boards. Each unit consists of two uprights made of 2x6-in. timbers, spaced apart by pieces of ¾-in. pipe, and held together by ¾-in. bolts passing through these pipes, washers being provided both under the bolt heads and nuts and also against the pipe ends.

At the top edge, the pieces have a 2x6-in. wooden spacer nailed between them to bring the top surface about ¾ in. below the ends of the uprights, so that a surfaced 1-in. board laid on top will come practically flush. At the bottom, a similar piece, preferably thicker to raise the floor boards a few inches is cut in flush with the bottom ends of the uprights. The row of units is then connected in any desired combination by two or more boards running lengthwise and nailed to the top and bottom cross-pieces, forming a solid floor below and a capacious shelf above.

In the illustration, no diagonal bracing is shown, as it is assumed that the rack in this case is bolted to the wall. Where the rack is to be placed in the middle of a room, or where there is no chance to tie it to something sufficiently solid, cross-braces running from the top of one end piece to the bottom of the other should be provided. As a rule it will be necessary to have this bracing, which should be of 1x6-in.





The rack is composed of the units shown at A, which are assembled as in diagram B.

strips, on one side of the rack only.

The units may be made in various dimensions, but for ordinary purposes the size described will be found adequate. The safe maximum load, if fairly evenly distributed, is 2 tons for each unit of this size, or a total capacity of 10 tons for the rack illustrated. If heavier loads are desired in a given space, it is merely necessary to loosen the boards and use more units placed closer together. On the other hand, for light stock such as tubing or aluminum, they can be strung further apart.

The construction which renders it possible to arrange the units in various ways also enables the rack to be readily moved in even a crowded shop without loss of time or damage to the rack. Two workmen can take apart and reassemble a rack such as that shown in less than an hour's time.

Jena, Germany. HENRY SIMON.

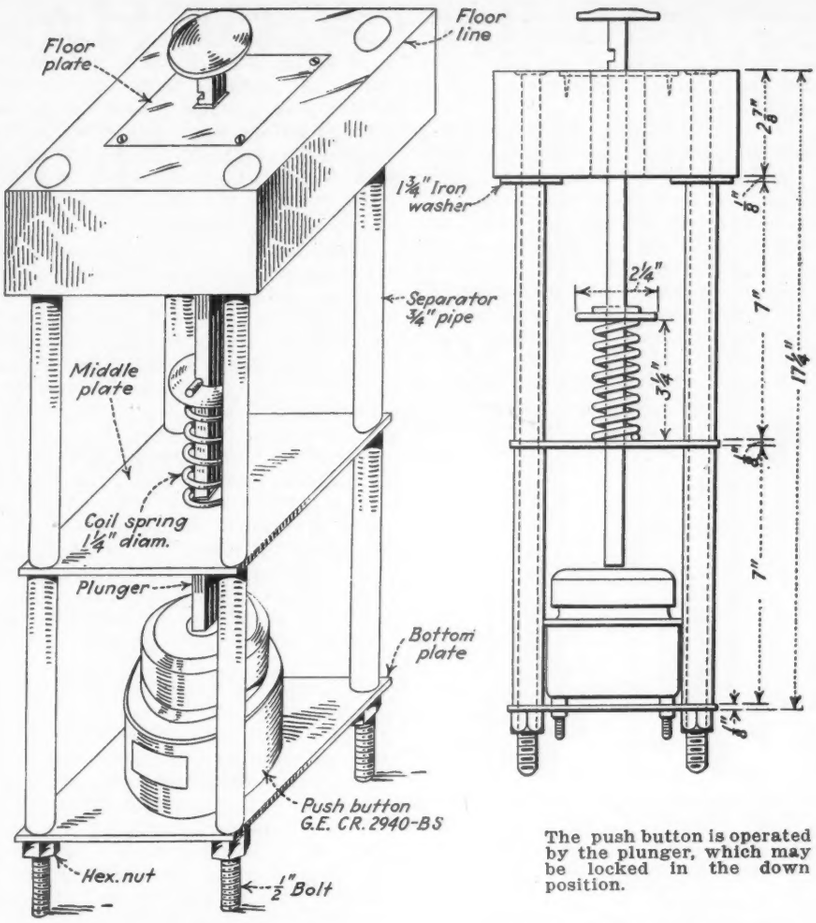
Locking Floor Button Controls Sawmill Equipment

THE illustration shows a locking floor button which we have constructed and used with much satisfaction for nearly a year. This button operates the valve on the bumper, allowing the slabs and rotten boards to go on down the roller case without passing through the edger.

At first we installed the buttons in a rack below the surface of the floor to protect them from being struck by slabs and boards; also, it was felt that mounting them in this way would make it easier to change them when necessary, which is an important consideration in a sawmill. We found, however, that the operator took his hands from the board and his mind from the work while operating the button and in the course of a day this caused a considerable amount of lost time. Therefore, it was decided to make a locking floor button.

In our first design we put slots in the plunger which was then made of ½-in. pipe. These slots were so arranged that when the button was depressed and given a quarter-turn either to the right or left it would stay down until released by turning back to the normal position. Although this design was satisfactory mechanically we found that bark and scrap kept getting under it so that the button would work only about half the time. To overcome this difficulty the arrangement shown in the illustration was worked out and adopted.

Essentially it consists of a plunger supported in a suitable framework and normally prevented from touching the push button, which is mounted beneath it, by a rather heavy coil spring. A slot in the plunger rod near the top permits locking it down until it is intentionally released. The heavy coil spring supporting the plunger gives a quick break when the plunger is released. This is an important feature particularly in the case of buttons that are used with direct-current solenoids.



The push button is operated by the plunger, which may be locked in the down position.

We are now using these floor-operated buttons on every installation possible, where a line starter is employed, as it is cheaper than the ordinary start-and-stop push-button station, and easier to maintain or replace when necessary.

Buttons for direct-current control are installed with a 2-ft. piece of Tirex cord and an attachment plug, which facilitates making quick changes.

Chief Electrician, JOHN EMIGH.
Clearwater Timber Company,
Lewiston, Idaho.

Changing a Twelve-Pole Motor to Eight Poles

THE problem of calculating a new winding to change the speed of a 75-hp., three-phase motor, brought out some interesting points that should be useful in solving other problems of a like nature.

The motor in question was a 75-hp., 440-volt, three-phase, 60-cycle, 600-r.p.m., twelve-pole motor. It had 135 slots of the partly closed type with 135 coils, each consisting of two turns on edge of 7/64 x ½-in. bare copper strap, each turn being insulated separately. The coils were threaded through the opening in the top of the slot. The coil pitch was 1-and-10, and the winding was connected series-star for 440 volts.

It was desired to change the winding to 900 r.p.m., or eight poles.

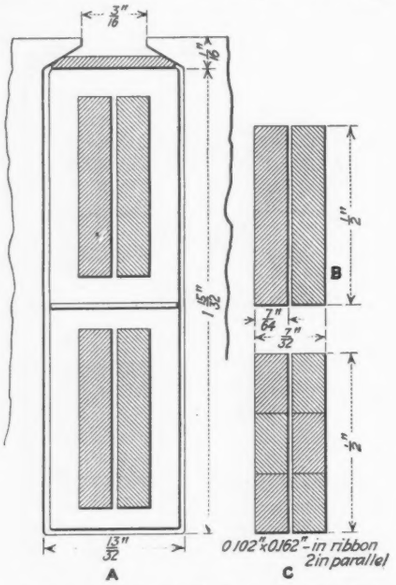
When the turns per coil are few, as in this case, the calculations should be reduced to volts per turn, as a fraction of a turn makes quite a difference in the required line voltage; also, with a large number of slots it requires considerable chording to make any material difference in the final voltage. With 135 two-turn coils there are 270 turns, or 270 ÷ 3 = 90 turns per phase.

This winding had a coil pitch of 1-and-10, which is 2¼ slots under pitch, as full pitch would be 11¼ slots; then, to avoid subsequent errors the voltage should be converted to full coil pitch voltage.

With 11¼ slots per pole, the electrical angle between slots is 180 ÷ 11.25 = 16 deg. Then a pitch of 1-and-10 has an angle of 9× 16 = 144 deg. The chord factor is the sine of 144 ÷ 2 = 72 deg. or sine = .951. Accordingly, full pitch line voltage is 440 ÷ .951 = 462.67 volts and volts per phase equal 462.67 ÷ 1.73 = 267.4 volts. Converting this into volts per turn, we have 267.4 ÷ 90 = 2.97 volts, for the twelve-pole winding. The volts per turn in-

crease in direct proportion to the speed increase; therefore, with the eight-pole, or 900-r.p.m., winding full pitch volts per turn will equal $600 \div 900 = 2.97 \div x$, or 4.455 volts.

For a series-star connection and a line voltage of 440, the volts per phase should be 254 volts, and turns per phase equal $254 \div 4.455 = 57$. With 135 coils there are 45 coils per phase, and with 57 turns and 45 coils the turns per coil required are $57 \div 45 = 1.27$. If one turn per coil were used the volts per phase become $45 \times 4.455 = 200$ volts and it would be necessary to use full pitch, which for eight poles is $135 \div 8 = 16.875$ slots, or a pitch of 1-and-17 could be used, if there were sufficient end room. However, this would increase the weight of copper



The original winding was arranged in the slots as shown in A. Dimensions of the copper section of the two-turn coil are shown in B. Diagram C. shows how the three-turn coils were arranged in the slots.

* * * *

required and would not make a good winding.

Next trying a series-delta connection, the turns per phase for a full-pitch winding become $440 \div 4.455 = 98.76$, or a two-turn coil could be used, but it would have the same disadvantages as the previous coil.

It is obvious that a two-turn coil and a two parallel star connection, or a four turn coil with a two-parallel-delta connection, is also out of the question.

A three-turn coil and a two-parallel-star connection would have the advantage that the winding could be chorded to get the effect of a 1¼-turn coil, and at the same time reduce the coil and extension, and keep the copper weight to a low value.

The three-turn coil would result in $45 \times 3 = 135$ turns per phase, at 4.455 volts per turn; the volts per phase become $135 \times 4.455 = 601$ volts. The series-star line voltage becomes $601 \times 1.73 = 1{,}040$ approximately and a two-parallel-star connection will give a line voltage of $1{,}040 \div 2 = 520$.

However, 440 volts were required and it was necessary to select a coil pitch having a chord factor that would reduce the effective turns, to give the desired line voltage. This factor is equal to $440 \div 520 = .846$, which is the sine of an angle of 57 deg. 47 min. The electrical angle of the required coil pitch is twice the angle given above, or 115 deg. 34 minutes.

Then, to convert this angle into coil pitch we must find the electrical angle between slots for the eight-pole winding, which has 16⅞ slots per pole; this angle equals $180 \div 16.875 = 10.6$ deg. Then the required coil pitch equals $115.567 \div 10.6 = 10.9$, or 11, resulting in a pitch of 1-and-12.

The problem of selecting a suitable winding was solved by deciding on the threaded-in type of coil, using double-cotton-covered ribbon wire. The coil ends were taped by the winder while installing the coils, and all insulation was placed in the slot, which meant that the coils were wound and then pulled to shape and all insulation was applied during the winding of the stator.

How the new copper size was selected is shown in diagrams *A*, *B* and *C* of the illustration. Diagram *A* shows the original winding in the slot. The problem was to divide the space taken up by a two-turn coil, into three turns. In *B* the copper section of the two-turn coil is shown as being 7/32 in. and ½ in. The same space has been divided into three turns depthwise, in *C*, each section being 7/32 in. wide by .167 in. deep. Dividing each section into two parts gives .109 in. x .167 in. The nearest standard ribbon wire size, .102 x .162 in. was selected.

Thus, the new winding data were 135 coils, each containing three turns of two .102 x .162-in. d.c.c. ribbon wires in parallel. The pitch was 1-and-12, and the coils were connected two-parallel-star, in 24 groups.

The coils were not insulated until installed, at which time the winder taped all coil ends. Those coils at the beginning and ending of each pole-phase group had one half-lapped layer of treated cloth tape, and one half-lapped layer of .007-in. cotton tape; all other coils in each group had one layer of .007-in. cotton tape, half lapped.

The slot insulation consisted of an .023-in. fishpaper cell bent to fit the slot, each coil half being threaded through the slot opening into an .010-in. treated cloth cell, which was cut off and folded over the top of each coil. A 1/32-in. fiber separator was used between the top and bottom coil halves, and allowed to extend ¾ in. past the end of the coil slot section.

The coils were dipped in a black plastic varnish and baked before winding in the stator, and after winding, the same varnish was poured over the coil ends, and the stator baked.

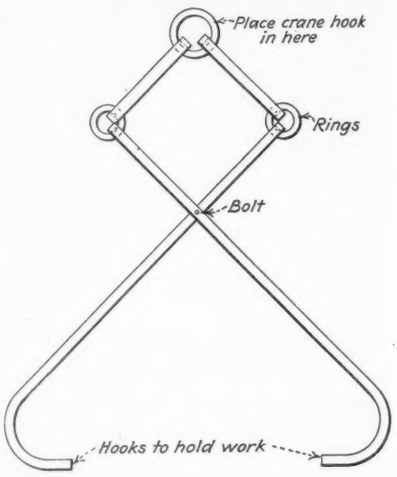
The leads of 24 coils were made long to allow their use as group connections or jumpers.

Wilkinsburg, Pa. A. C. Roe.

Crane Hooks That Facilitate Handling of Flat Objects

THE hooks shown in the illustration were designed to facilitate the handling of plates and similar loads by a crane. The heavier the load, the tighter the hooks will hold.

The crane hook should be placed in the top ring. This ring and the side rings are connected by two steel rods or chains. The hooks should be made



The heavier the load, the tighter the grip of these hooks.

* * * *

of steel and the entire unit can be made as heavy as required for the work that is being handled.

Hooks made in this way can be used for a wide variety of work that is difficult to handle with chains or slings, and the usual form of crane hook.

Denver, Colo. R. M. Thomas.

Grounding Electric Drills Insures Safety of Operator

PORTABLE electric drills are tools that are called upon to withstand unusually hard service. This results in frequent repairs due to the cords becoming worn, defective switches, or grounds caused by chips entering the ventilation holes in the casing. A recent occurrence prompted me to adopt on all electric drills in our shop the safety precaution described below.

A workman was about to drill a hole when, due to a defective switch which became grounded to the casing, he was thrown violently to the floor, and the point of the drill was burned.

The addition of a third wire, to act as a ground wire, has proved effective. One end of the wire is attached to the casing of the drill by a screw. The other end of the wire carries a clamp that is attached to a water pipe, radiator, or any other object that will serve to give a good connection. For convenience in handling, this wire is wrapped around the current-carrying wire, the clamp end being about 6 ft. longer.

Philadelphia, Pa. R. H. Kasper.

ADAPTING AUTO-STARTERS TO CHANGED CONDITIONS

By C. A. JOHNSON
Electrical Engineer

In the preceding article in the November issue, some of the principles involved in the operation of auto-transformer starters were discussed from the standpoint of their effect in making changes in the operating conditions. In particular, the value of current flow, including the magnetizing current, in the different sections of the winding was considered at length.

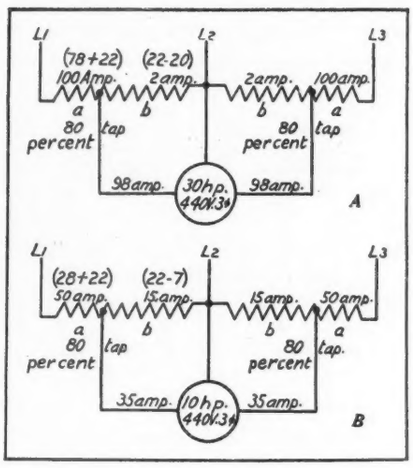


Fig. 1—Distribution of current in windings of auto-transformer starter during starting period.

* * * *

LET us now consider the current taken from the line. This is made up of two components: the energy component and the magnetizing component. If the magnetizing component of the transformer subtracts from the magnetizing current of the motor in section *b* of the transformer winding in Fig. 1, the heating effect in that section will be comparatively small. By properly designing the short section, *a*, of the transformer winding so as to keep down the I^2R loss, the actual loss in the transformer can be made low.

This condition is obtained by having the transformer exciting current approximately equivalent to the exciting current of the motor, and holds good for only one particular size and design of motor. When designing commercial auto-transformers it is necessary to select a motor magnetizing current that represents the average value, and then make the magnetizing current of the transformer equal to this value.

The windings of the transformer must be proportioned for the worst condition which is obtained in section *a* of the winding when the largest motor is being used, and in section *b* of the transformer winding when the difference between the motor magnetizing current and the transformer magnetizing current is a maximum. An additional allowance must also be made for small differences in phase angles.

It will thus be seen that the exciting current of a properly-designed auto-transformer for intermittent starting should be much larger than for power transformers. This excess magnetizing current will overheat section *b* of the transformer winding if left on for any considerable length of time without the motor load, because there is no cancellation of current in this section of the transformer winding.

The exciting current varies with the voltage and the frequency. Each time the magnetism in the iron reverses it generates a voltage in the transformer windings. The product of the magnetism multiplied by the number of turns in the coil, multiplied by the frequency, must balance the line voltage. As the number of turns in the coils has a fixed value for a particular design, an increase in voltage at a constant frequency would require a corresponding increase in magnetism in order to balance this increased line voltage. If the voltage remains constant and the frequency decreases, an increase in magnetism would be required to make this product constant.

When the iron in an auto-transformer is worked hard, as is the case in a starting transformer, an increase in magnetism requires a considerable increase in exciting current, the iron loss going up quite rapidly at this part of the magnetization curve. Therefore, any unusual increase in voltage, or decrease in frequency, will cause a proportionally large increase in the exciting current.

Standard auto-transformers are designed and guaranteed to operate successfully on 10 per cent variation in the line voltage, provided the frequency remains constant. The converse is also true; if the line voltage remains constant the frequency may vary. This, however, is a rather unusual condition.

The function of an auto-starter is to supply the motor with a combined voltage and current suitable to provide sufficient torque to start any given load; hence, the following remarks on motor torque will enable one to consider a phase, voltage, or frequency change in terms of a voltage change, and its consequent effect on the starting duty of apparatus.

The torque of an induction motor varies as the square of the voltage. It is usual to express the starting characteristics of an induction motor by stating that it has a certain locked torque. This is the torque exerted when the rotor is held stationary and normal voltage is applied to the primary windings. The torque is usually expressed in terms of the full-load torque. Thus, a motor having a locked torque of 2, means that the torque at zero speed is equal to twice full-load torque with normal voltage on the primary.

If 70 per cent of voltage were applied to the motor primary, the motor would exert a torque equivalent to 2×0.7^2, or 98 per cent of full-load torque. The torque at any other starting voltage can be obtained by

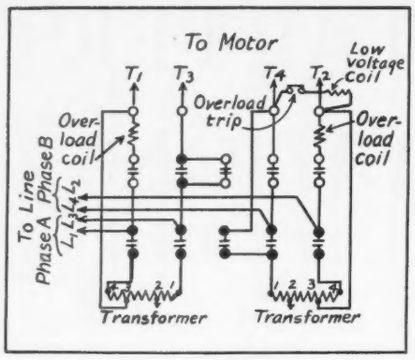


Fig. 2—To adopt a two-phase, four-wire auto-starter for use on a two-phase, three-wire system, connect $L3$ to $L4$ and $T3$ to $T4$. The two-phase, three-wire line connects to $L1$, $L3$, $L2$, and the two-phase three-wire motor to $T1$, $T3$, $T2$. The common return from the line connects to $L3$ and the common return from the motor to $T3$.

* * * *

expressing this voltage as a fraction, squaring it, and multiplying by the locked torque given in percent of full-load torque.

The starting torque is independent of the method employed for obtaining the reduced voltage. The taps on an auto-transformer are usually expressed in percentage of full voltage. These percentage ratios are not exact, as it is necessary to compensate for the voltage drop through the transformer. This compensation differs with different motors, owing to the variation in the starting current.

The difference in voltage may seem trivial, but it must be remembered that this difference is squared, and that only a little extra torque may be required to break the load from the static position and allow the motor to start. As soon as the motor commences to rotate the friction decreases and the torque gradually increases, so that the critical period is the instant of starting from rest.

Some motors exert a slightly different torque when starting from rest, depending upon the location of the rotor slots relative to the primary winding. This variation of starting torque is usually quite small, but may be appreciable in some particular motors; it should, therefore, be taken into consideration in comparing starters.

The starting voltage can be adjusted by changing the starting connection from one transformer tap to another. Some transformers are provided with 65 or 80 per cent taps. These give 42 and 64 per cent locked torque of the motor when starting. For smaller motors, less than 42 per cent of the locked torque is not necessary, but the larger starters have a 50 per cent tap, which will provide 25 per cent of locked torque for light starting conditions.

Where intermediate values of starting torque are necessary they can be obtained by connecting one starting lead to the next higher starting tap; for example, if one side is connected to the 65 per cent tap, and the other side to the 80 per cent tap, an intermediate value of starting torque will be obtained with an intermediate value of power input. Connections of this kind unbalance the phases so that more current is taken from one phase than from the other. The amount of this unbalancing, however, is considerably less than the difference in voltages after the motor begins to revolve. In no case is the current taken from either phase greater than would be taken if both leads were connected to the higher voltage.

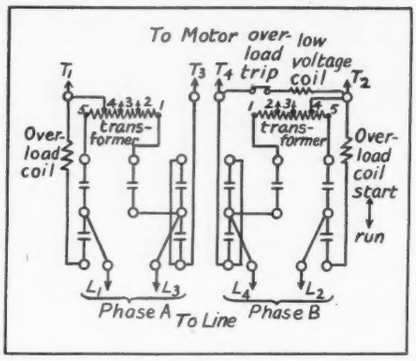


Fig. 4—Here is another type of two-phase starter. To adapt it for a two-phase, three-wire system, $L3$ is connected to $L4$ and $T3$ to $T4$, as in the previous case. The common return of the three-wire line is connected to $L3$ on the line side and to $T3$ on the motor side.

* * * *

In general, using a given starter for a smaller motor means that all overload and other current-limiting devices must be reset.

In the preceding article the changes that may be desired in auto-starters were listed. Case 1 of that list (using a starter of a given rating with a smaller motor) was considered in that article. With the background that has been given the other changes can now be taken up.

Case 2. Changing from four-wire to three-wire, two-phase. This is a simple change on almost any two-phase starter. Fig. 2 shows the points to be interconnected to give correct operation.

The point to check is to see that the two proper line and motor leads are connected together for the common return, and that the protective coils are in the outside leg. Fig. 3 shows an automatic, two-phase, four-wire starter connection and the method of changing for two-phase, three-wire operation. Also, Fig. 4 shows the connections for a different type of starter.

Case 3. Changing from two- to three-phase. Any two-phase, four-

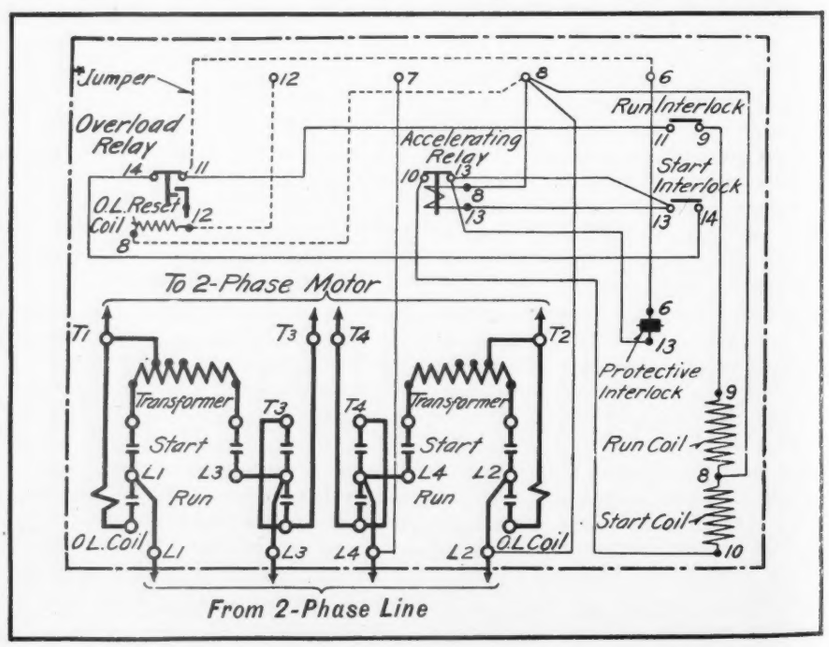


Fig. 3—Internal connection diagram for automatic two-phase, four-wire starter. For use on a two-phase, three-wire system $L3$ is connected to $L4$ and $T3$ to $T4$. The line is connected to $L1$, $L3$, $L2$, and the motor to $T1$, $T3$, $T2$, the common line being connected to $L3$, and the common motor lead to $T3$.

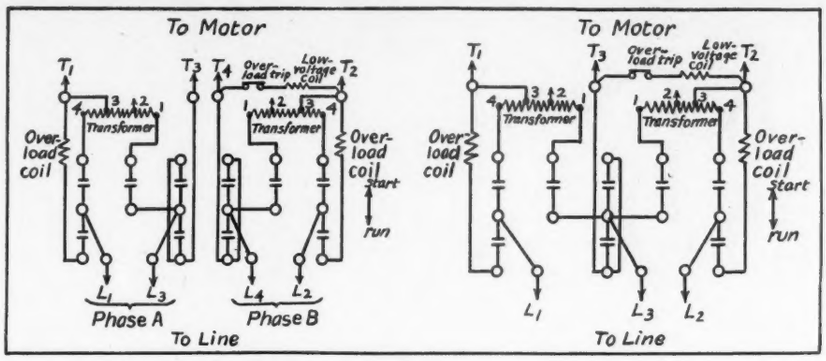


Fig. 5—Adapting a two-phase starter for use with a three-phase motor. The two-phase connection diagram is shown left. For three-phase service connect *L3* to *L4* and *T3* to *T4*, giving the three-phase arrangement shown right. The line is connected to *L1*, *L3*, *L2*, and the motor to *T1*, *T3*, *T2*.

wire starter that can be changed to operate two-phase, three-wire, can also be used to start a three-phase motor of the same voltage, horsepower, and so on. The alterations are made as outlined for the two-phase, four-wire to two-phase three-wire change, except that all current protective units must be reset, as there is a difference in the current ratings of two- and three-phase motors of the same horsepower and voltage. Fig. 5 shows the necessary changes in the connections.

Any two-coil, three-phase starter can also be used for two-phase, three-wire service, as shown in the above diagrams. However, three-phase starters having three coils cannot be changed to two-phase, three- or four-wire starters, as a study of Fig. 7 will show.

CASE 4. Change in voltage. The windings of the auto-transformers used in starters are of the fixed-winding type, and cannot be rearranged or reconnected for a straight voltage change, such as 110 to 220 volts, 220 to 440 volts, or *vice versa*, with the horsepower remaining the same. The customary 10 per cent voltage variation cannot be considered as a change.

There are a few combination changes, such as cycle and voltage, and so on, that can be made, and these will be discussed later.

Nevertheless, as stated above, the windings of the coil are fixed; thus the current-carrying capacity is fixed. This feature can be used to advantage as follows: A given auto-starter can be used on a lower voltage to start a smaller motor, provided that the motor current does not exceed the normal current rating of the transformer coils. Thus, a 50-hp., 440-volt starter can be used to start a 25-hp., 220-volt motor, but it should be understood that the low-voltage release coil and any other voltage coils will have to be replaced by 220-volt coils, or rewound for 220 volts.

CASE 5. Using a 25-cycle starter on 60 cycles. In general, the transformer coils of an auto-starter will operate satisfactorily when changed to a higher frequency, as 25 to 40, 25 to 50, or 25 to 60, but all voltage coils must be changed, as a 25-cycle holding coil will not hold on 60 cycles.

The low-voltage coils for 25 cycles are generally provided with copper shading coils, and when changing to a higher frequency the shading coil should be changed to brass.

CASE 6. Using a 60-cycle starter on a lower frequency. If a 60-cycle starter were used on 25 cycles the transformer coil would burn out, unless the voltage could be reduced in the same proportion as the frequency; when reducing the frequency the voltage must also be reduced. Thus,

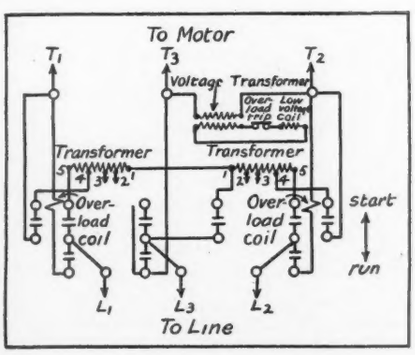


Fig. 6—When using a three-phase auto-starter with a two-phase motor on a two-phase, three-wire system, connect the common return from the line to *L3*, and the common return from the motor to *T3*. This diagram refers to a 2,200-volt starter.

a 550-volt, 60-cycle transformer and holding coil can be used on 440 volts, 50 cycles, with a motor smaller in rating in the same proportion that the voltage was reduced from the normal. Or, a 550-volt, 60-cycle coil can be used for a 220-volt, 25-cycle motor. In both cases a copper shading coil would have to be used, as mentioned heretofore.

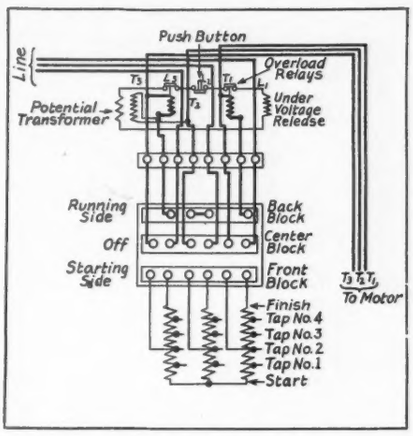


Fig. 7—Three-phase starters having three coils can not be reconnected for two-phase, three- or four-wire service.

* * * *

The aforesaid remarks pertain to voltage as well as auto-transformer coils, and it should be borne in mind that the current ratings should not exceed the normal for any change, when using the same coils.

When contemplating any of the above changes it is necessary to study the effect on each unit—transformer, current coils, and voltage coils—and if in doubt, consult the manufacturer of the apparatus.

Modernizing Old Motor Windings

(*Continued from page* 637)

with red tape or paint so that it can be identified when connecting up. Alternate with four- and three-turn coils until nine groups of eight coils have been put in. These nine groups will have 72 coils, 36 four-turn and 36 three-turn.

Next put in 21 four-turn coils, and to start the next three groups of eight coils put in a four-turn coil, then a three-turn, and alternate until 24 coils are placed.

The foregoing example shows what can be accomplished with the worst type of bar and end connection winding encountered, as the new winding is of the diamond pulled coil, two coil per slot, two layer type which is cheaper to make and install.

QUESTIONS
Asked and Answered
By Readers

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only condition is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

What Proportion of Oven Area Should be in Explosion Panels?

In obtaining figures on box-type enameling ovens lately, I noticed that none of the companies agreed as to the percentage of oven area that should be in explosion panels. As this seems to be a most important factor I recommended to our purchasing department that the one having the largest area in explosion panels be given preferences. Although this is playing safe it is not good engineering as even the one with the greatest area may not be safe. If anyone has any test data on this subject or knows of any accepted standards I would appreciate hearing from him.

Toledo, Ohio. I. M. G.

Using Wattmeter to Measure Reactive Kva.

1. Will someone tell me whether an ordinary wattmeter can be used to register the reactive kva. in a circuit? If so, how should it be connected?

2. Some time ago I saw a description of an electrical method of connecting together two polyphase motors so that when one of the rotors is turned a portion of a revolution the other rotor will turn likewise. I shall appreciate any information you can give me regarding this arrangement.

Philadelphia, Pa. L. S.

Chain Length Determination

Several years ago our plant was thoroughly modernized, overhead shafting was reduced to a minimum, drive centers were shortened, chain was used as the drive medium between the motor and the countershaft, but belts were retained to provide a flexible connection between the countershaft and the machines.

Outside of ordinary repairs we have had no trouble with the chain drive, but it is time to consider replacing several that are in continuous service. From one angle I am told that the ordinary formula for chain length is used to determine the length, and from another, various values must be used in conjunction with the formula. Are these values then, standard for all chains or are they set up by the various manufacturers for their particular type of chain? How then, is the length of chain determined for a drive having sprockets with 19 and 75 teeth, a 42-in. center distance, and ⅞-in. pitch?

Cleveland, Ohio R. V. L.

Brushes and Vacuum

Without going into a highly-technical discussion, is it possible for someone to explain the action of equipment affected by brush vacuum? To the lay mind the subject is quite obscure, and it seems to me that in attempting to explain it for their benefit, the technician will be able to grasp it quicker. To what extent does it affect the capacity of generating equipment? How can one recognize the symptoms? What is the treatment recommended with the brushes in use? How is the effect determined so as to specify the correct brushes? Diagrams would be appreciated as well as interesting experiences in this connection.

Grand Rapids, Mich. C. V. D.

Effect of Low Voltage on D.C. Motors

I wish some reader would tell me how the voltage drop in a power line affects the power developed by a d.c. motor. For example, we have a 10-hp., 230-volt, 1,750-r.p.m., compound, ball-bearing motor installed in a mine about 1½ miles from the power supply. The full-load current of the motor is 39 amp. Under a recent test the motor drew 40 amp. at 150 volts. What power was developed by the motor? With normal voltage a 5-hp. motor would be large enough to handle the load. Under our conditions would it be advisable to use a smaller motor? Why?

St. Louis, Mo. C. O. L.

Is Back-Torque Operation of Slipring Hoist Motor Harmful?

We are having trouble with the brake of a 75-hp. slipring induction motor that operates a hoist. In order to save the brake the hoist operator was instructed to lower the skip by applying current in the hoisting position. The question has come up as to whether the motor may be injured or partially burned out.

After the hoist had been operated in this way for some time I felt the motor, and found the temperature was about normal, but the resistance grids were very hot. I should like to know whether there is any danger of injuring the motor by operating it in this way, and whether it can be considered good practice.

Flin Flon, Man., Canada. A. P.

What Causes Heating of These Cables?

I wish someone would tell me why the cables on our electric bread-baking oven heat up. From the 800-amp. oil circuit breaker two 500,000-circ. mil., varnished cambric cables for each of the three phases pass through a 5 ft. 5 in. length of iron conduit. The cables then run open for a short distance and finally enter two 3-in. iron conduits spaced on 6-in. centers running to the oven, which is about 800 ft. away. At the oven the two cables for each phase are connected to a common bus. We were careful to keep the proper phase relation, so that each conduit contains one A-, one B-, and one C-phase cable. The load varies from 600 to 800 amp., and when it is on, the cables heat up badly and the two conduits become very warm for their entire length, although not exposed to external heat. I believe that if the cables had been run in one conduit, there would have been no appreciable amount of heating.

Will readers let me know whether this view is correct? If not, what causes this heating?

Somerville, Mass. B. C.

ANSWERS *Received to Questions Asked*

Choice of Voltage for Operating Single-Phase Motors

In a new plant that is being erected there will be a number of ¼-hp., single-phase motors for operating small drills and other tools. A question has arisen as to whether there is any choice between 110- and 220-volt motors in regard to torque, power factor, ability to maintain full speed under rated load, and so on. In other words, what advantages, if any will be obtained by using 220 volts, instead of 110 volts, for these small motors? Your comments will be appreciated.
Lowell, Mass. A. A. D.

ANSWERING A. A. D. there is practically no choice between 110-volt and 220-volt motors as regards torque, power factor, efficiency, etc. Some types of single-phase motors are designed so that identically the same motor is used on either 110 volts or 220 volts, merely by putting coils in multiple or connecting them in series with each other.

This is accomplished by interchanging the motor lead connections. Consequently, the voltage and current conditions on the coils themselves are the same whether the motor runs on 110 volts or on 220 volts, and the performance of the motor will be the same.

Accidental contact with 220 volts is more disagreeable to the individual than contact with 110 volts, but with ordinary care in installing and insulating, there should be no choice in favor of 110 volts over 220 volts. As a matter of fact, 440 volts alternating current is quite commonly used in industrial applications of ten horsepower and above.

The question of copper in the electrical supply lines should be considered if there are a large number of motors installed. The copper supply lines must be of a certain size in any event in order to be of the requisite mechanical strength! So it may be found that nothing can be saved in the size of the wire by selecting 220 volts rather than 110 volts. On the other hand, if there are a large number of motors, it may be found that less copper will be needed for a 220-volt installation than for 110 volts.

R. F. EMERSON.
Industrial Engineering Department,
General Electric Company,
Schenectady, N. Y.

THE choice of voltage for the motors of small portable electric drills has been brought up by A.A.D.

There is no choice in regard to power factor, speed or torque. These are practically the same for any ¼-hp. motor, regardless of whether it operates at 110 or 220 volts.

Current consumption is the main consideration, with the question of grounding also to be decided. Motors built for 110 volts will take approximately double the current and, consequently, feeder wires of twice the cross-sectional area that would be required for the same number of the same size motors built for 220 volts. According to the National Electrical Code all rotating machinery operating at more than 150 volts should be grounded, which for portable motors would require a three-wire cable.

To summarize, 110-volt motors would require only a two-wire cable, but feeders must be twice as large as for 220-volt motors. Feeders for 220-volt motors could be only half the size of those for 110-volt machines, but the 220-volt motors would need a three-wire cable.

On the whole the 110-volt installation would probably be better for long service because of the lower voltage and certainly would be safer for workmen to handle. I would use 110-volt motors for these two reasons.

Instructor, EDWARD A. GIBBS.
Franklin Union,
Boston, Mass.

IT is assumed that A. A. D. has split-phase motors in mind. From the viewpoint of one who has engaged in electrical repair work for some time, I would not use 220-volt split-phase motors for the purpose outlined by him. There is, however, no difference in operation as regards full speed, torque, and so on.

The only possible advantage would be that a smaller size of wire might be used if several motors were on the same feeder. This would, however, be overbalanced by the extra cost of the motors, which is from one to two dollars more for the 220-volt type.

There are several disadvantages. In the first place it is not so convenient to move a 220-volt motor anywhere one pleases and be able to get current from any lamp socket, although sometimes it is profitable to take the machine to the work.

Again, nearly all makes of motors have the same insulation for both voltages and also use the same centrifugal switch for cutting out the starting winding. It is evident that 220-volt motors will tend to break down more quickly from an accumulation of oil and dirt. One end of the starting winding is always permanently connected to one side of the circuit, which leaves full voltage between the two windings all of the time. Dirt usually finds plenty of holes to work into, but where it does not seem to do very much harm on 110 volts, 220 volts finds the weak places a lot quicker.

For these reasons it is my opinion that 220-volt motors of the split-phase type should be used only where 110 volts is not available.

Longview, Wash. C. L. HARTMAN.

What Causes Poor Starting of This Motor?

We have a G. E., 30-hp., 220-volt, 900-r.p.m., Type K2-10A, Form K, wound-rotor motor from which we removed the sliprings and shorted the slipring connections. We now find that sometimes the motor will not start until the rotor is moved slightly. When the rotor is not on this particular spot the motor will start and when it comes up to speed the pulling power is normal. We have tested for shorts and grounds and could not find these or any other defects. Can any readers tell me the cause and remedy for this condition?
Logan, W. Va. B. S.

IN his question B. S. gives the type of his motor as K-2, and the form also as K. Attention is called to the fact that the manufacturer of this motor uses the form letter M for the wound-rotor type motor, rather than the letter K.

There is no reason why this wound-rotor motor should not operate satisfactorily with the secondary circuit short circuited. However, the performance will be considerably different from that with resistance in the secondary. In the first place, the starting torque available will be greatly reduced, probably to approximately one-third of the value with resistance in the circuit. If this motor is used on the same load that it was used on before, and the starting torque required is high, it is very likely that the failure to start is due to this reason. The fact that the motor will start sometimes and not others is not necessarily alarming, as there might be a point at which the torque is just low enough to prevent starting the load.

This statement is based on the assumption that the design of the motor is standard and the machine has not been changed in any way from its original condition. Care should also be taken to see that the short circuit in the secondary is well made, as the motor might start the load with only two of the secondary circuits connected together. In this condition, although the motor would start, the starting torque would be quite low and the performance would be erratic. If it is possible to open up the secondary circuit, it would be advisable to check the voltage across the three leads with the secondary open and voltage applied to the primary. If this is done, the voltage applied to the primary should be in the neighborhood of 15 or 20 per cent of the normal, full-load voltage, as the secondary open-circuit voltage is probably quite high, with full voltage applied to the primary.

As B. S. states, it is unlikely that there are any shorts or grounds in the machine itself, and if the windings are in perfect condition, the dead point noticed is a possibility. Slipring motors are not designed for operation with

ANSWERS *Received to Questions Asked*

the rings shorted, as is being done. However, if the starting torque required and the objectionable heavy starting current cause no disturbing effects on the system, there is no reason why the machine cannot be used. Attention should be called to the fact, however, that if the size of the distribution system to which this motor is connected is not sufficient to handle the heavy inrush of current, a voltage drop at the terminals of the motor during the starting period might be sufficient to reduce the torque of the motor below the amount required to start the load. If this were just slightly under the amount of torque required, it would be possible by pushing the machinery by hand to provide sufficient torque to get it under way. If such a condition were present, when the motor got up to somewhere near full speed, the voltage would again rise and the motor operate in normal fashion.

JAS. B. HOLSTON.
Wagner Electrical Corporation,
Chicago, Ill.

Supporting Brick Walls Where Holes Are Cut Through

We are installing a conveyor system between departments, and it will be necessary to cut holes through several interior brick walls supporting part of the weight of the upper floor, and separating the departments. These holes will be about 4 ft. wide and 3 ft. high. The walls are about 8 in. thick and we are wondering whether, if we cut square holes, it will be necessary to use I-beams to support the bricks above the holes. In one case there will be 17 ft. of wall above the hole; in other places the height ranges from 12 to 15 ft. Would there be any advantage in cutting the hole rounding, or arch-shaped, or pointed at the top? We should like to avoid putting in I-beams, but do not want the walls to be dangerously weakened. Your advice will be appreciated.
Newark, N. J. A. I. M.

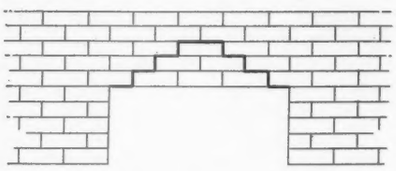
IN answer to A. I. M.'s question, if the holes have to be square it will be necessary to support the bricks above them in some way. Should the use of an I-beam not be desirable, the same effect can be produced by casting in a concrete beam reinforced with about four ⅜-in. bars.

It seems to me that the best solution is to make the top of the holes arched, setting the bricks on edge, with a key brick in the center of the span.

MAURICE C. COCKSHOTT.
Arcadia, Calif.

REFERRING to A. I. M.'s inquiry, it is usually considered that the lintel over an opening in a brick wall supports a triangle of brick whose height is one-third the width of the opening. Above this point the bricks will form their own arch since, as ordinarily laid, the bricks on each side will step out to cover the opening at approximately this height, as shown by the heavy lines in the accompanying sketch.

In the present case, if there is not too much vibration, leaving the top of the opening thus might be allowable. However, considering the comparatively small cost it would probably be well worth while to use a lintel made of an 8-in. channel laid flat with the flanges up and extending back one brick into the wall at each side. This arrangement would permit keying up the brick over the opening in good shape and prevent any loosening or cracking if the mortar started to give way due to vibration.



As ordinarily laid, the bricks above an opening in a wall form an arch at a height above the opening that is one-third its width.

* * * *

H. D. FISHER.
Plant Engineer,
New Haven Pulp & Board Company
New Haven, Conn.

How Should This Lineshaft Be Driven?

I wish that readers would give me the benefit of their experience on the following problem: We want to rearrange the machines in one department and install a new lineshaft which will be driven by a 40-hp., 900-r.p.m. squirrel-cage motor. The shaft speed will be about 275 r.p.m. Heretofore we have always used a belt drive between motors and lineshafts, but in this instance it is impossible to obtain the proper center distance. The motor can be mounted close to the shaft, on about 7-ft. centers, or about 32 ft. away, which would require an unusually long belt and in view of the rather wide variation in load we are afraid that trouble will be experienced from flapping of the belt. It has been suggested that we use (1) a short-center belt drive with an idler or, (2), a chain drive. Again it is possible that a belt drive on 32-ft. centers would not give us trouble; we are not sure. Which drive would you advise us to use? Why?
Columbus, Ohio F. A. V.

IN our plant we had a problem similar to F. A. V.'s, in designing a drive for a triplex cold water pump. We tried to use material we had on hand and had to employ a compound drive in order to get the desired speed. The pump had a lift of 70 ft. into an open tank, and the motor was controlled by an automatic starter with a float switch to govern the water level.

Our greatest difficulty was in starting; at times the belt would slip and flap badly while picking up the load, and eventually we burned out sections of the belt twice when stalling of the pump caused the belt to slip.

At length we substituted a chain drive using one speed reduction only; this simplified the drive and gave us considerably more space around the pump. The drive is simple and effective and has given no trouble since its installation. It requires very little attention other than an occasional lubricating.

Another advantage is apparent in the matter of guarding. The transmission belt guard was a rather cumbersome affair and shut off considerable light. The chain drive operates on about 6-ft. centers and with its guard constitutes a neat and compact installation. Altogether, we are very well satisfied with the change we made.

Ansonia, Conn. W. T. E.

REFERRING to F. A. V.'s question, as we understand his problem the distance between the centers of the motor shaft and lineshaft is so short that it is not practicable to use a belt drive. In this case, I would recommend a Texrope drive, consisting of one sheave pulley for the motor, one sheave pulley for the lineshaft, and about eight Texropes. With this type of drive, it is not necessary to have the Texrope or small V-belt tight. This drive will eliminate excessive bearing wear, and with it the maximum power can be developed with a minimum amount of slippage.

We have these drives installed in our plant in capacities ranging from 5 hp. up to 125 hp. They have given excellent service, and although some of the drives are now two years old, we have not had to make any replacements.

W. E. SOOY.
Secretary,
Michigan Carton Company,
Battle Creek, Mich.

ABOUT three years ago, we were confronted with the same problem that F. A. V. brings up. We have a lineshaft turning at 150 r.p.m., which is driven by a 50-hp., 600-r.p.m. motor through an Allis-Chalmers Texrope belt operating on 9-ft. centers.

We also have another 50-hp. drive for a rubber calendar. On this drive a Texrope belt operates on 2-ft. centers, giving a speed reduction from 900 r.p.m. to 450 r.p.m.

Recently we have installed this type of drive to replace chain drive on sewing machine lines driven by 2-hp., 1,800- r.p.m. motors at 450 r.p.m., on 21-in. centers.

From our experience, I would not hesitate to install a Texrope drive on the 7-ft. center, 3¼-to-1 reduction mentioned by F. A. V., and should expect no maintenance expense beyond taking up the slack after a month or two of service.

J. J. WYNHOFF.
Electrical Engineer,
Chicago Rubber Clothing Company,
Racine, Wis.

ANSWERS *Received to Questions Asked*

Operating 60-Cycle Motor on 50 Cycles

Will readers please tell me whether it will be safe to operate a 300-hp., 2,300-volt, three-phase, 60-cycle, slipring motor on a three-phase, 2,300-volt, 50-cycle circuit? I understand that there will be a change in the speed and should like to know whether any other characteristics will be changed, as well as any precautions that should be observed in operating this motor on 50 cycles instead of 60 cycles. D.M.
Hannibal, Mo.

ANSWERING D. M., operating 60-cycle motors at rated 60-cycle voltage at their rated horsepower on 50 cycles, will result in an increase in the operating temperature. Whether or not this temperature will be high enough to be dangerous depends on the liberality of the design.

There will be an increase in the magnetizing current and iron losses. This, together with the decreased ventilation at the 50-cycle speed, results in the higher operating temperature. The power factor and efficiency will be lower and there will be an increase in the line current. With a motor of this size it is quite possible, however, that it will be found to operate on 50 cycles at rated 60-cycle voltage, without reaching a dangerous temperature.

The proper thing to do, if possible, would be to decrease the operating voltage in proportion to the frequency—that is, to about 1,920 volts—and decrease the horsepower rating of the motor in proportion to the change in speed or frequency. If it is found that the voltage cannot be reduced to 1,920 volts, reducing it to 2,100 volts would be satisfactory, as this would bring it within 10 per cent of the corresponding 50-cycle voltage, which is the limit of voltage variation for which most motors are built and guaranteed.

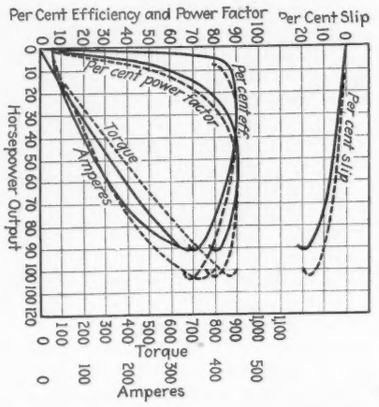
General Engineer, R. P. GUILDFORD.
Westinghouse Electric & Manufacturing Company,
Philadelphia, Pa.

IF a 60-cycle induction motor is operated on a 50-cycle circuit as D. M. proposes, there will be a decrease in synchronous speed exactly in proportion to the decrease in the frequency. Probably the next most noticeable difference when operating on 50 cycles will be an increase in heating. This is due mainly to two reasons: When running on the lower frequency, there is a reduced cooling effect from the lower windage which, of course, is a direct result of the motor running at a lower speed. The second reason is increased core loss and increased magnetizing current.

As the magnetic reversals are slower on the lower frequency, more time is allowed for the magnetism to build up in the iron during each half cycle, which tends to increase the iron heating. This is independent of the load on the motor, and exists at no load as well as at overloads. Unless the motor in question is now overheating from carrying a load that taxes its capacity on 60 cycles, it may be expected that it will give satisfactory operation so far as heating is concerned when running on a 50-cycle circuit.

A decrease in the frequency will mean a considerable increase in pull-out torque. This will favor operation of the motor. If it now drives a load having a high static friction, where the torque is taxed to get the load moving from rest, it may be found that this trouble will disappear.

Such a condition exists where a motor drives a conveyor or crusher, as it takes considerable torque to get the load started. Also, if the motor has been subjected to high peak loads when operating which threaten to stall it, it



Characteristics of 35-hp., 60-cycle squirrel-cage motor operated on two frequencies. The full line represents the 60-cycle curves; the dotted line represents 50-cycle operation.

* * * *

may now be found that the motor can successfully handle these peak loads. On the other hand, if the motor drives a load similar to a fan, where the static friction is very low, and there are no high load peaks, this change in the torque characteristics will be of no particular benefit.

The accompanying diagram indicates the characteristics of a 35-hp., squirrel-cage motor, showing values of efficiency, power factor, torque, current and slip for this particular motor at both frequencies. This motor is an obsolete design of the squirrel-cage type, but will serve to show in general how this particular induction motor behaved when operating on two frequencies.

The following changes in characteristics may be noted when operating on 50 cycles: There is a reduction in power factor and efficiency on the lower loads, but an increase at the higher loads, although at full load this particular motor shows a higher efficiency and a lower power factor. There is a general increase in torque, particularly in the maximum running or pull-out torque. The slip is shown to be less on 50 cycles than on 60 cycles, but, in general, it can be said that the slip of an induction motor operating on a changed frequency can be considered to be practically unaltered.

R. F. EMERSON.
Industrial Engineering Dept.,
General Electric Company,
Schenectady, N. Y.

Measuring Belt Tension

In articles on the use of belting for power transmission, the statement is frequently made that the tension on the belt should be so many pounds per inch of width. No doubt this is an important point, but I should like to know how I can measure the tension of leather, rubber or fabric belts while they are on the pulleys. Is there any apparatus or reasonably simple method of measuring belt tension, that can be used out in the shop? W. E. F.
Detroit, Mich.

ANSWERING W. E. F., of the suggested methods for measuring tension in belts, we know of but one practical way. This is by means of spring scales fastened between one of the clamps on one end of the rods, the clamps and rods referred to being the set used to install the belt or to shorten it. By means of these clamps, rods, and spring scales, a belt may be pulled up to a pre-determined tension, thereby eliminating the necessity of knowing the initial stretch of the belt, as the initial stretch will automatically be pulled out when the belt is drawn up to the desired tension.

Very few companies have conscientiously followed the practice of installing belts by this means, although the practice has merit and eliminates the hazards of guessing. However, the average belt man dislikes the additional trouble of using clamps and rods equipped with spring scales, as they are harder to handle. In the case of wide belts, more than 36 in., the average smooth-faced clamp will slip before the belt can be pulled up to a normal tension per inch of width, as used on narrower belts; that is why wider belts often must be shortened soon after being installed and put into operation.

Clamps that have corrugated faces for the purpose of keeping the belt from slipping often injure the fiber where they are clamped on, if they are screwed or tightened enough to keep the belt from slipping.

At one time a Philadelphia concern built a small instrument similar to the tension gages for measuring tension in wires or cables. We understand that the instrument was not practical, in that variations in pliability and thickness of belts made it difficult to measure the tension accurately.

Chief Engineer, ROY C. MOORE.
Chas. A. Schieren Company,
New York, N. Y.

NEW EQUIPMENT

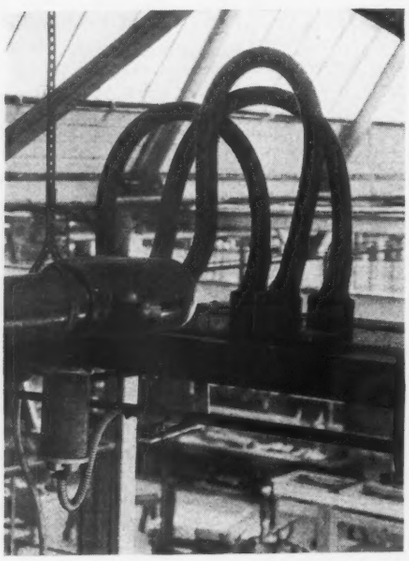
For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Bull Dog Electric "Bus-Duct" and "Trolley-Duct"

APPARATUS for mass production announced by the Bull Dog Electric Products Company, 7601 Jos. Campau Ave., Detroit, Mich., includes two systems: "Bus-Duct," designed to supplant wires, conduits and distributing panels in plants where motors and machines are frequently shifted to meet production schedules; and "Trolley-Duct," a flexible system of electrical control for portable tools used on assembly lines in mass-production plants.

Bus-Duct consists essentially of bus bars, properly insulated and installed in a metal trough or duct having bakelite receptacles connected to them with regular spacing throughout their length for the reception of "Fusible Switch Plugs" which, in turn, are connected by flexible cable to the motor or machine they control. When a machine's location is changed the fusible switch plug goes with it and is "plugged in" to a receptable in the bus-duct at the machine's new location.



Main feeder cables connected to tap-offs in the bus duct.

Bus-Duct is furnished in standard lengths of 10 ft., with a plug receptable on 40-in. centers but with provisions for installing receptacles on 20-in. centers. The inclosing metal trough or duct is the same size as Bull Dog "Pro-Duct" (for wires) and is equally complete as regards ells, tees and other fittings.

Bus bars are made standard in 300- and 600-amp. capacities and are totally inclosed and insulated by horn fiber tubing throughout their length. In joining sections of bus-duct together, one end of the bus bar terminates in a jaw with a clamping bolt and nut through it. The slotted end of the adjoining bus bar fits over this clamping bolt and between the jaw. The two sections are then clamped together by tightening the nut from the top. Fiber tubes slipped over the joint and held in place with rawhide pins complete the insulation of the bus bar.

Receptacles are made of molded bakelite built up of sections designed to permit of their being assembled on or detached from the bus bars.

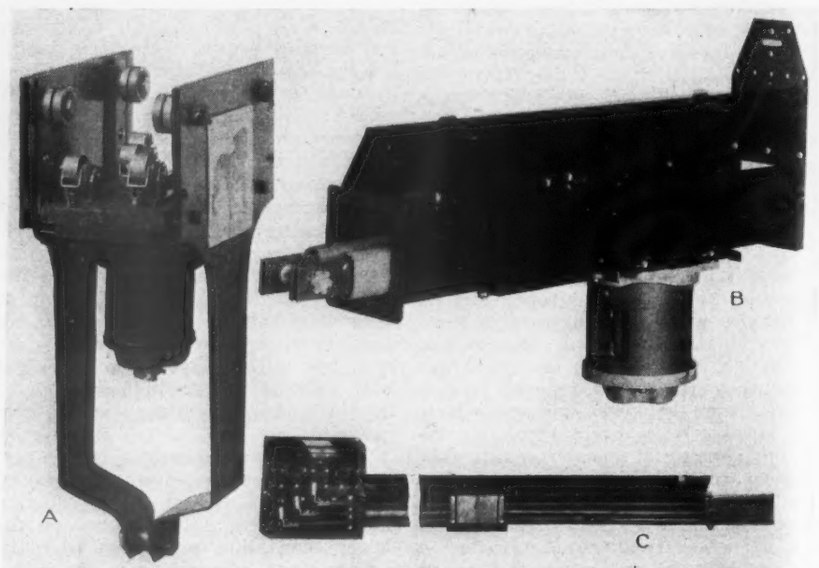
Fusible switch plugs are furnished in standard sizes with cartridge fuse connections for 30, 60, 100, and 200 amp. at 250 volts, and 30, 60, 100, and 200 amp. at 600 volts.

A plug consists of a bakelite housing with an aluminum casting at each end which protects and completes the plug. Cartridge fuses are accessible through a window in the bakelite housing, which may be revolved to bring the window opposite any fuse. An interlocking mechanism makes it impossible to replace fuses without first disconnecting the plug from the bus-duct. Grounding is automatically accomplished when the plugs are inserted in the receptacles by means of the metal parts on the plugs whereby the latter are clamped to the duct. The receptacles are, in turn, keyed to the duct, so that they may be placed in only one position. Hence the system is always polarized and, once a plug is connected to a motor, the latter will always have the correct rotation.

Bus duct serving a plant whose manufacturing activities are not of a permanent nature.

Power may be fed to the bus-duct from the ends, but special conditions of installation with tap-offs in any section of the bus-duct, as illustrated can be made.

Trolley-Duct consists essentially of



(A) Balancer-type carriage which moves along the bus in the channel feeding current through the fusible switch plug to the portable tool below. (B) Section of bus duct with fusible switch plug attached. (C) Top view of a section of bus duct with the hinged cover raised.

standard lengths of 5-in. steel channel, mounted inverted—the top part of which constitutes the track for the trolley carriage. On the bottom side, bus bars, suitably insulated, are installed. Suitable taps are provided to feed the bus bar, which has a capacity of approximately 150 amperes.

Current is taken from the bus bars by means of collector wheels in the trolley carriage and conveyed through fuses to the cord connecting the individual portable tools. The bus bars are so arranged that one is mounted about ¼ in. higher than the others; thus the carriages cannot be reversed, assuring that the tools will always operate correctly.

There are two types of trolley carriages: (1) The heavy-duty, balancer-type carriage is semi-permanent as compared with (2) the portable-type, which can be instantly detached from one section of the trolley-duct and snapped onto another section.

By removing a few bolts the heavy-duty, balancer-type carriage can be taken off the trolley-duct and put in another location. There are two collector wheels spaced several inches apart so that it is impossible for the tools to operate single-phase. A fusible-plug receptacle is incorporated in these carriages, having fuse connections for 30-amp. 250-volt, and 30-amp. 600-volt cartridge fuses.

Although the portable-type carriage is lighter in construction it is similar to the balancer type and can be instantly attached to or detached from the trolley-duct. In the portable type, the fuse block for 250 volts is mounted in the carriage proper, while for 600 volts it is mounted on the handle directly under the carriage.

Both carriages have ball-bearing rollers for support as well as ball-thrust side bearings which keep them from being locked in any position on the channel.

An installation of trolley duct with portable carriages serving individual portables below.

Cutler-Hammer Counter E.M.F. Automatic Starter

A COUNTER E.M.F. automatic starter, rated up to 2 hp. at 115 or 230 volts, is announced by Cutler-Hammer, Inc., 150—12th St., Milwaukee, Wis., for small d. c. motor applications.

It consists of a main line contactor, an accelerating contactor, and an armature resistor. On depressing the start button of the master switch the main line contactor connects the motor to the line through the armature resistor. As the motor accelerates to the proper point, the counter e.m.f. of the motor armature closes the accelerating contactor which cuts out the armature resistor, connecting the motor across the line.

Each starter is supplied with a separate pushbutton master switch providing three-wire remote control. Two-wire control can be furnished if desired. The standard starter is supplied with thermal overload relays, but starters without the relays are also available. These relays are of the fusible alloy type and can be made applicable to motors of various sizes by simply changing the heater coils.

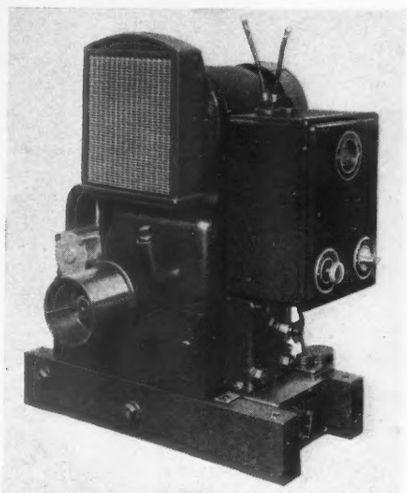
Fairbanks-Morse Light Plant for Auxiliary Service

TO provide small, isolated plant operators with a source of power to supply illumination for night work, Fairbanks-Morse & Company, Chicago, Ill., has developed a compact, self-contained lighting plant at 750- and 1,500-watt sizes.

These units are adaptable for use on cranes, dredges, and excavating equipment to supply the adequate illumination that is required on jobs which necessitate 24-hr. a day operation. In the assembly the power unit, the ignition system, the generator end, and the control mechanism are maintained as separate units. The engine used is the Fairbanks-Morse, Self-Oiling "Z" engine with high-tension magneto ignition. The smaller 1½-hp. unit is designed to operate on gasoline as fuel, whereas the 3-hp. engine can use either gasoline or kerosene. The generator is mounted as a unit directly above the engine and driven by means of a Flex-Mor "V" belt.

All control mechanism is contained in the inclosed box mounted as a unit on the main frame. It consists of a pushbutton start and a "high-low-belt" switch which permits the storage battery to be charged at a rapid rate for regular charges or at a low rate for an equalizing charge.

In the "belt" position the generator is electrically disconnected from the engine so that the entire power output is available for mechanical work from a pulley on the engine shaft. No cranking is required as the generator acts as a motor during the starting period. Ignition is furnished by a high-tension rotary magneto which is a complete generating unit in itself and entirely independent of the condition of the storage battery of the plant.



Fairbanks-Morse Lighting Plant for Auxiliary Service

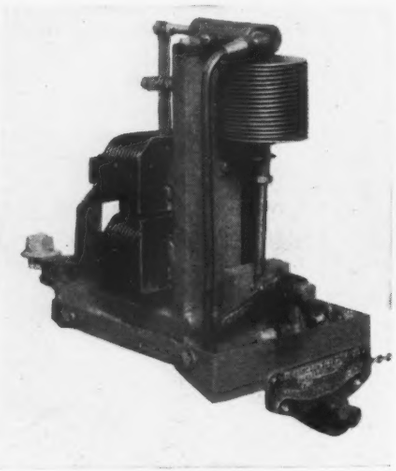
The plant is water cooled by means of a radiator and fan and water circulating system similar to that employed by the standard automobile engine.

Although this plant is built in two sizes it is offered with a variety of storage battery combinations which will meet almost any demand placed on the unit for either a 32-volt or a standard 115-volt circuit. Either size can also be furnished for direct lighting when it is desired to operate without the storage battery in which case a special control panel is provided on which is mounted a voltmeter, an ammeter, and a field rheostat which permits of voltage regulation of the generator to meet the demands of the load.

Lincoln Idling Device for "Stable Arc" Welders

AN automatic idling device or throttle control for regulating the speed of the engine in Lincoln Stable Arc welders of the gasoline engine-driven type has recently been perfected by The Lincoln Electric Company, Cleveland, Ohio. The device automatically increases the speed of the engine from normal idling speed to the proper speed for welding service whenever the arc is struck. When welding is discontinued the device automatically reduces the speed of the engine to normal idling speed.

The operating mechanism of the device consists principally of a small metal bellows and an electric magnet. When the arc is struck the armature of the electric magnet opens a relief valve in the bellows, causing them to inflate, which in turn allows a coil spring to open the engine throttle. When the welding operation ceases the bellows are deflated by the suction of the engine intake, thus causing the closing of the engine throttle to the idling position. The idling device is provided with a control lever which may be set for automatic throttle control, for continuous idling speed, or for governed speed.

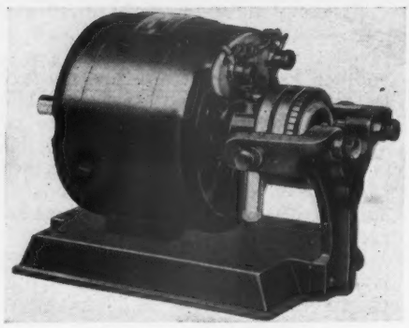


Idling Device for Lincoln Stable Arc Welders

The device is so designed that a momentary interruption in welding will not cause a reduction in the speed of the engine.

Bodine Motor-Driven Pole Changer

A MOTOR-DRIVEN contact maker for converting direct current to alternating current by reversing the direct current through a special commutator has been developed by the Bodine Electric Company, 2254 West Ohio St., Chicago, Ill. Direct current is fed to the commutator through a pair of slip rings and the output is taken from brushes in contact with the commutator.

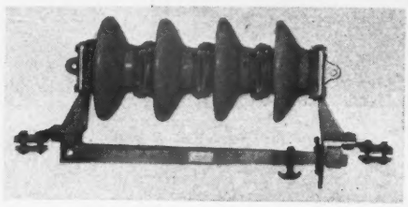


Bodine Motor-Driven Pole Changer

The motor can be wound for any a.c. or d.c. voltage and has no electrical connection with the slip rings or commutator. The equipment can be used for selective frequency ringing or for any purpose requiring an alternating current. These units are made in capacities of 100 watts or higher.

Champion Hook-Stick Disconnecting Switch

A SUSPENSION-TYPE line hook-stick operated disconnecting switch has been developed by The Champion Switch Company, Kenova, W. Va., in various voltages and a wide range of current capacities.



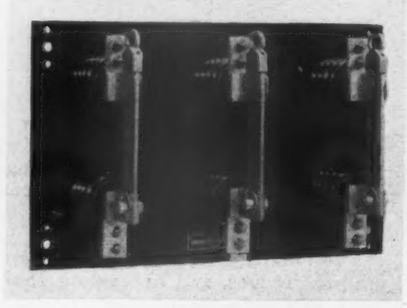
Hook-Stick Operated Champion Disconnecting Switch

The interchangeable units are shunted by a reinforced truss blade in turn provided with blade guides, lugs and compression-type solderless connectors.

Delta-Star Grouped Switch Units

THE Delta-Star Electric Company, Chicago, Ill., has developed a grouped unit consisting of three single-pole disconnects mounted on a steel base ready for immediate installation.

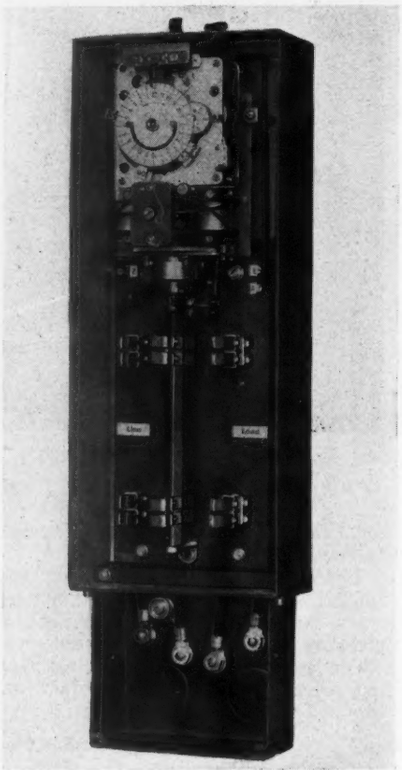
The bases are drilled for mounting directly on flat surfaces by means of four bolts or, by using U bolts the bases can be mounted on pipe structures. The switches with their positive safety locks and contact blocks are mounted on standardized brown-glaze interchangeable insulators.



Delta-Star Grouped Switch Units

"Sauter" Self-Winding Time Switch

THE "Sauter" single-throw, self-winding time switch illustrated, now being distributed by the R. W. Cramer & Company, 236 Liberty St., New York City, is used to control blowers, pumps, ventilators and other electrical circuits that can be operated on a predetermined time basis.



"Sauter" Self-Winding Time Switch for Circuit Control

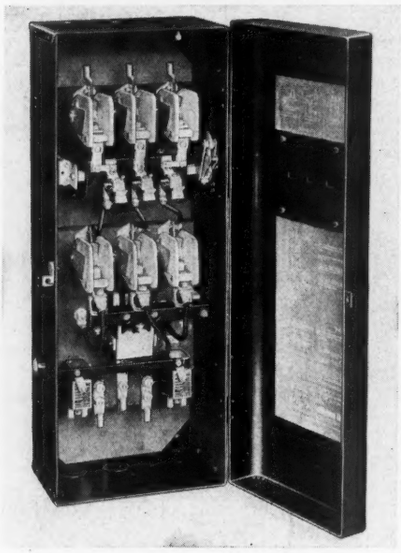
The main switch is motor operated, the motor of which is of the series-wound type with a jumper arrangement on the field coils to permit operation on 115- and 230-volt d.c. or a.c. circuits of any frequency. The clock has a four-day main-spring, but is rewound automatically twice every 24 hours.

The clock can be furnished with a Sunday cut-out, automatically causing the switch to suspend its functions every seventh day. A single 24-hr. dial serves both for time setting and for program setting. Where it is desired to have the operations conform to a constant schedule the plain dial is used.

Allen-Bradley A. C. Motor Starters

THE Allen-Bradley Company, 286 Greenfield Ave., Milwaukee, Wis., now furnish its standard a.c. across-the-line switches equipped with hand-operated disconect switches and meter test jacks in one cabinet.

The disconnect switches are furnished with or without fuse clips. The meter test jacks permit the motor to be tested for load without opening switch cabinet or interfering with machine operation.



Allen-Bradley A. C. Motor Starters with Disconnect Switches and Meter Test Jacks

These switches provide overload, dead-phase, and no-voltage protection, and are rated up to 10 hp. at 110 volts, 30 hp. at 220 volts, and 60 hp. at 440-550 volts. They are furnished in three forms: Form 1 with push buttons in the cover; Form 2 for pilot control and Form 3 with three-way lever switch.

General Electric Control Switch

A SWITCH, designated as the Type CR-7006-F-1, was recently developed by the General Electric Company, Schenectady, N. Y., to take the place of the magnetic switch, motor circuit switch and inclosed fuses usually required in controlling the operation of a motor. This switch can be applied to control any motor where a general-purpose magnetic switch would be used, and where its special features are desirable.

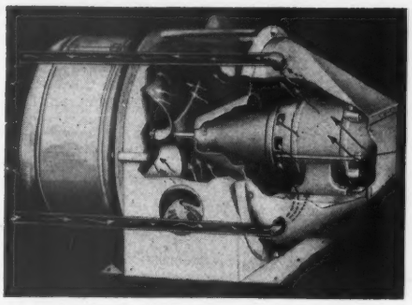
The switch consists of three sections; a back portion containing a motor circuit switch, a middle portion containing a base on the front of which the magnetic switch is mounted and on the back of which clips are provided for fuses, and the front cover. The back portion is built for mounting directly on a wall.

Overload protection is provided by two temperature over-load relays which open the contactor when overloads occur. The relays are so designed that they will trip the contact mechanism just before the overload will cause the motor to be excessively heated. The switch is furnished with a holding interlock which permits its use with a "Start-Stop," momentary-contact, push-button station. When such a push-button station is used, if the voltage fails, the contactor will open and will not close automatically on return of voltage, making it necessary to press the "start" button to restart the motor.

Paasche "Explosion-Proof" Ventilating Unit

AN "explosion-proof" ventilating unit electrically welded and bolted, and suitable for a variety of ventilating conditions owing to its convertibility and flexibility is being marketed by the Paasche Airbrush Company, 1909-1923 Diversey Parkway, Chicago, Illinois.

According to the manufacturer, some of the outstanding features are: specially designed and balanced aluminum fan; fans easily detached or attached on self-centering tapered shaft with



Paasche "Explosion-Proof" Ventilating Unit

puller and tightener nut; clean-out sleeve with door for quick removal of fan; specially designed motor with sealed sleeve bearings. Oiling feature at one location reached through door; motor housing designed so that inlet opening may be placed at horizontal or vertical position with inlet to right, left, top or bottom; motor housing completely seals the motor away from the path of the lacquer mist from entering the motor frame or mounting.

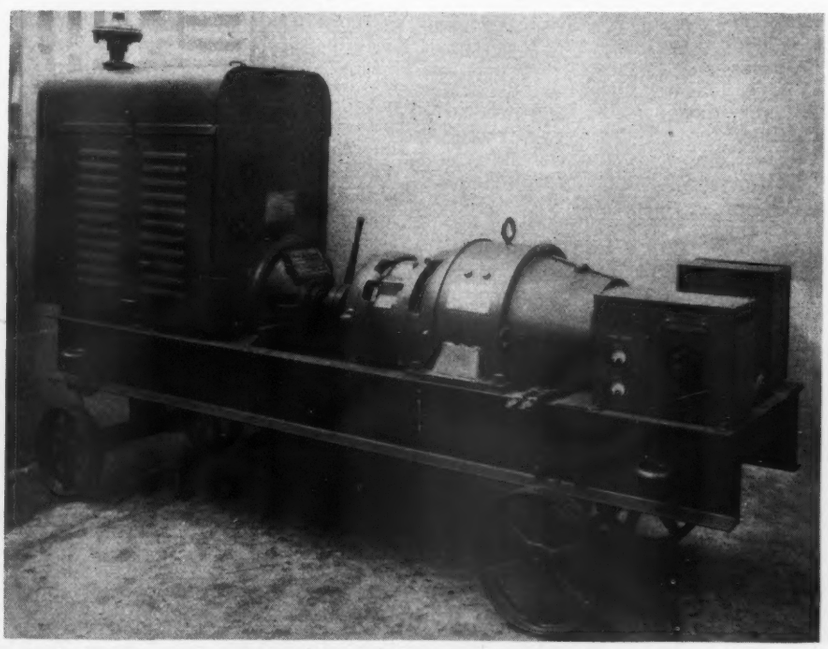
A flexible pipe supplies air circulation for cooling from the outside of the building. The unit is supplied in four sizes and may be furnished with either a.c. or d.c. motors.

Westinghouse Dual-Drive Welding Unit

A DUAL-DRIVE, arc welding unit, introduced by the Westinghouse Electric & Manufacturing Company, E. Pittsburgh, Pa., consists of a standard, 300-amp., single-operator welding generator, a 15-hp., a.c. motor and a six-cylinder, 1,800-r.p.m., Model P-45, Continental gas engine, all mounted in tandem on a welded steel base.

The motor operates on 220 volts, but by reconnecting the external motor leads and changing the linestarter coil, it can be used on 440 volts. The welding generator can be driven by either the gasoline engine or the electric motor by simply engaging or disengaging a slip coupling or clutch, whichever is provided.

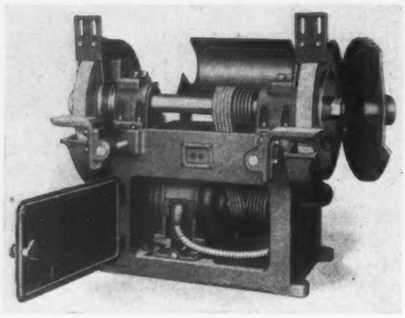
The dual drive welding machines can be furnished in all the popular, single-operator ratings, stationary or portable.



Westinghouse Dual-Drive Welding Unit

Hisey-Wolf High-Speed Snagging Grinders

OF the two high-speed grinders announced by The Hisey-Wolf Machine Company, Cincinnati, Ohio, the single-speed type is recommended



Hisey-Wolf High-Speed Snagging Grinder

where a number of machines in operation offer an opportunity to change the wheels as they wear to a machine of higher spindle speed thereby maintaining approximately the original peripheral speed. These machines are made in three sizes for 18-, 20-, and 24-in. wheels.

In the multi-speed machine this condition is maintained by changing the Texrope driving belts to a different set of pulleys.

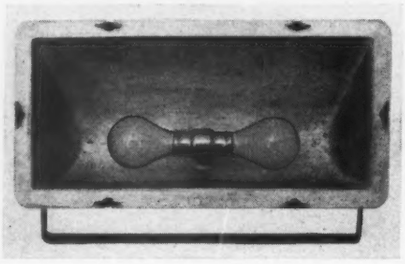
Both types have extra large spindles running in ball or roller bearings protected from dust and grit by labyrinth seals. The adjustable guards are interlocked with the speed-changing device automatically insuring against excessive wheel speeds.

Headley Emulsified Products

THE Headley Emulsified Products Company is successor to the Headley Good Roads Company, Philadelphia, Pa., manufacturer of emulsified asphalt products, and has expanded this line to cover industrial uses such as waterproofing, dampproofing, and protective coatings for all types of structures, railroad platforms and crossings, and highway construction and maintenance.

G. E. Cornice Lighting Unit

INTRODUCED by the General Electric Company, Schenectady, N. Y., this floodlight which is suitable for mounting on the top of a cornice to eliminate the shadow created from floodlights mounted below, has a low mounting height so that it will not be conspicuous.

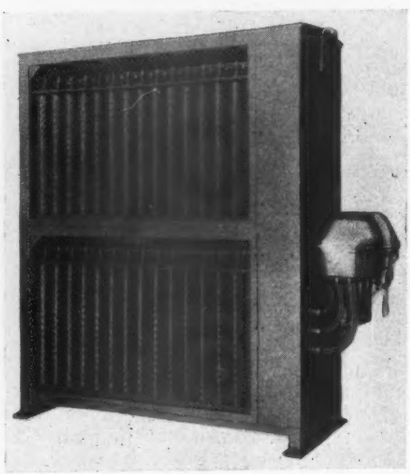


G. E. Cornice Lighting Unit

Known as Type L-32, it consists of a hot-dip galvanized, cast-iron casing equipped with a twin socket for two 50-, 60-, 75- or 100-watt general service lamps. The inner surface of the casing is sprayed with several coats of aluminum paint, providing a reflecting surface and giving a wide distribution of light. By means of a trunnion bracket, provided for mounting, the casing may be adjusted to any position. The floodlight is provided with a clear glass door, but color plates are available if required.

Electric Machinery Cell-Type Capacitor

EACH cell in the E-M Capacitor developed by the Electric Machinery Manufacturing Company, Minneapolis, Minn., is a capacitor unit; the total kva. required being obtained by the use of



Electric Machinery Cell-Type Capacitor

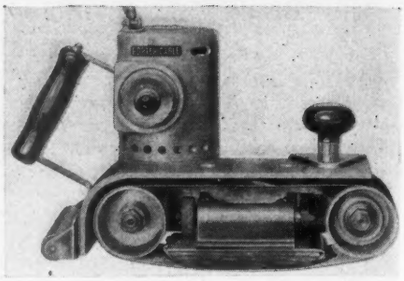
a suitable number of calls connected in parallel.

Individual capacitor rolls, the working element in the capacitor cell, are mounted on a supporting rack and sealed under oil in the cell. Stands for holding the cells are of welded, sheet-steel construction and of such character that the unit may be shipped completely assembled for installation.

Porter-Cable High-Frequency Sander

SIMILAR in many respects to the Types B-4 and B-5, this Type B-7, Take-About, hand-belt sander put out by The Porter-Cable Machine Company, Syracuse, N. Y., is equipped with a 1½-hp., 10,800-r.p.m., 220-volt motor for operation on a frequency of 180 cycles.

By the selection of the proper grits this sander may be adapted for grinding or polishing any flat or slightly curved surface. Included in the specifications are the following: Belt speed, 1,800 f.p.m.; belt size, 3x25¾ in.; pulley diameter, 2¾ in.; weight, 21 lb. Standard equipment includes 6 belts, a ½-in. felt-covered shoe, and a 20-ft. rubber-covered, four-conductor cable without plug.



Porter-Cable Type B-7 Take-About High-Frequency Sander

Oster Williams Merge

THROUGH the merger of the Oster Manufacturing Company, Cleveland, Ohio, and the Williams Tool Corporation, Erie, Pa., two representative lines of pipe-threading equipment have been brought together.

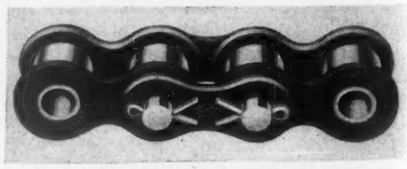
Tools made by the Oster Manufacturing Company include the "Bull-Pup," "Leader," and "Bull-Dog" pipe-threading tools; the "Power Boy" portable pipe machine; and belt and motor-driven machines from ¼- to 8-in. capacities.

The Williams Tool Corporation manufactures a line of standard and "rapiduction" pipe machines from ¼- to 8-in. capacity, inclusive; pipe cutting-off machinery; and both single- and double-spindle bolt machines.

Diamond 2½-In. Pitch Roller Chain

DEVELOPED by the Diamond Chain and Manufacturing Company, Indianapolis, Ind., the 2½-in. pitch chain shown in the accompanying illustration conforms to the A.S.M.E., S.A.E., A.S.M.A., and the American Standards, according to the announcement. It is similar to all Diamond Roller Chain in design but made for heavy-duty applications such as large conveyors, industrial locomotives, and so on.

For single-strand chains, the average tensile strength is 95,000 lb.; maximum hp., 97; maximum r.p.m., 240 with 19-tooth sprocket. It is made in single and multiple strands, transmission capacity and tensile strength being proportional to the number of strands.



Diamond 2½-in. Pitch Roller Chain

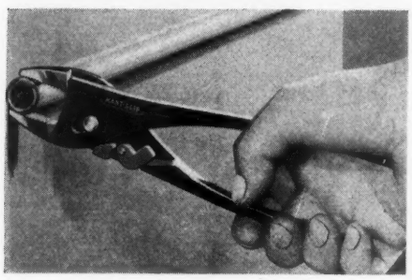
Stanley Electric Acquires Ajax Hammer Corporation

THE Stanley Electric Tool Company, subsidiary of the Stanley Works, New Britain, Conn., has acquired the Ajax Hammer Corporation, 117 West 63rd Street, New York, N. Y., manufacturer of electric hammers used extensively for construction and maintenance work.

Distribution will continue through regular established jobbing channels. Inquiries regarding service, repairs as well as tools, should be addressed to the Stanley Electric Tool Company, New Britain, Connecticut.

Kant Slip Pliers

CAM, fulcrum, and wedge actions are combined in the Kant Slip pliers offered by the Kant Slip Plier and Tool Company, 6036-38 Wentworth Ave., Chicago, Ill. Because of its jaw



Kant Slip Pliers

action and clamping power round, square, hexagonal or objects of any other shape are held vice-like with little effort.

Falk Flexible Couplings Distributed by Jobbers

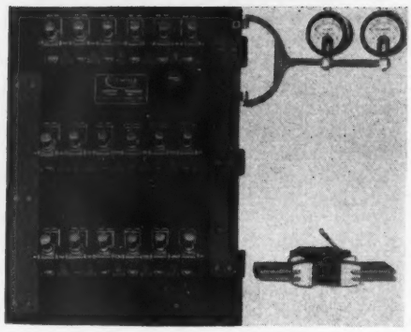
THE Falk Corporation, Milwaukee, Wis., has adopted the method of distributing Falk Flexible Couplings through leading distributors of mill machinery and electrical supplies located at strategic points throughout the country.

This change has been made by the Falk Corporation as a step toward more efficient distribution of couplings and greater service to users.

Columbia Cast-Grid Tank Rheostats

UNIFORM in cross sections, the cast-grid tank rheostats, manufactured by the Columbia Electric Manufacturing Company, 1292 East 53rd St., Cleveland, Ohio, are mounted in the rear of the panel on three mica insulated tie-rods which are suspended and insulated from the ventilated inclosure. Rigid three point support eliminates breakage caused by sagging or vibration.

On the ebonite operating panel is mounted a series of renewable, current-carrying contact studs and fingers



Columbia Cast-Grid Tank Rheostat

which are brought into circuit by raising the cam action toggles. Each contactor controls one section of resistance which may be introduced into the circuit as required. Mounted on a swinging bracket, the volt meter and ammeter may be moved to allow reading from any angle.

These rheostats are manufactured in standard sections of 800-amp. capacity or smaller, which are mounted together for units of greater capacity.

G.E. Inside Color-Processed Lamps

DEVELOPMENT work has been completed, according to an announcement from the Edison and National lamp works of the General Electric Company, Schenectady, N. Y., on the application of the inside colored process to the 10-watt, 110-, 115-, 120-volt, S-11, intermediate, screw-base Mazda lamp. Three lamps which were formerly supplied only in the outside colors are now available in the inside colored finish in the full line of standard colors, including red, yellow, green, blue, amber-orange, flametint and white.

With the inside colored finish the bulb has a smooth outside surface, which has less tendency to collect dirt, is more easily cleaned, and the colors are not affected by the weather.

Haynes Hascrome Welding Rod

THE Haynes Stellite Company, Kokomo, Ind., has placed on the market a manganese-chrome-iron welding rod called Hascrome, which was designed primarily for building up worn parts preparatory to surfacing them with Stellite. Although in some cases Hascrome alone may be used for hard-surfacing parts subject to abrasive wear, it does not possess rod hardness to the same degree as Stellite.

Because the hardness of the deposited metal can be controlled by the amount of excess acetylene as well as by the rate of cooling this metal is best applied by the oxy-acetylene process, however, it may be applied by means of the electric arc by making the rod the positive electrode.

The deposit has a tensile strength of 40,000, and a compressive strength of 177,000 lb. per sq. in. By varying the process of depositing, any hardness between 240 and 500 Brinell may be obtained.

Heppenstall-Gellert Automatic Safety Tongs

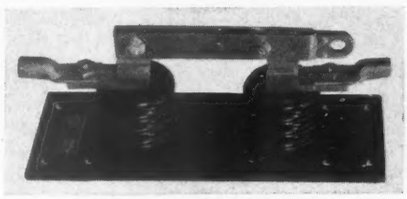
PATENTED lifting tongs, known as the Gellert Automatic Safety Tongs, have been introduced by the Heppenstall Forge and Knife Company, Pittsburgh, Pa. Suspended from any kind of hoist by a single rope, they are manipulated by means of this rope only and by the craneman alone without any auxiliary men, power or appliance. The tongs are normally in the open position; a single down and up movement grips the load, and the subsequent down and up movement releases it, leaving the tongs again in the open position ready for gripping.

According to the announcement, the device is positive in action, and low in weight, as the latch contains only two moving parts. No springs or counterweights are used and no lubrication, attention, or adjustment is required. The tongs may be used for handling hot and cold steel ingots, molds, slabs, and large bales of various kinds.

Delta-Star Tongue-Type Disconnecting Switches

AN improved and simpler form of tongue-type disconnecting switches has been developed by the Delta-Star Electric Company, Chicago, Ill.

The blades are adjustable and any wear of the contact surfaces can easily



Delta-Star Tongue-Type Disconnecting Switch

be compensated for. The insulator units are interchangeable and the base can be mounted on flat surfaces or on 1¼-in. pipe by means of U bolts.

Trumbull Electric Equipment Available Through Western Subsidiary

THE Trumbull Electric Manufacturing Company, Plainville, Conn., has formed the A. D. Electric Manufacturing Company, Seattle, Washington, as successor to the A. D. Manufacturing Company, in which the Trumbull organization has secured controlling financial interest.

Both companies will work together in an endeavor to serve the electrical industry of the far west on safety switches, panel boards, switchboards, and other accessories.

Goodyear Compass Endless-Cord Belt

AN endless-cord transmission belt, known as the Goodyear Compass endless belt, was recently announced by the Goodyear Tire and Rubber Company, Inc., Akron, Ohio.

The Compass belt, according to the

Goodyear Compass Endless-Cord Belt

manufacturer, differs from ordinary fabric belts, made endless with a splice, in that it has no splice in the core of cords which carries the load. The cords are imbedded in rubber and covered by an elastic, rubberized, fabric envelope. This envelope takes all of the surface wear, and since it is elastic, all of the load is properly thrown on the load carrying cords.

It is recommended by the manufacturer for belt drives on equipment such as air compressors, vacuum pumps, rock drills, ice machines, feed grinders, wood planers, spinning frames, Lenix drives, Pullmax drives, and other high-speed, small pulley drives.

The Compass belt also is furnished by the manufacturer in cut lengths for oil field work and for cone drives in textile plants.

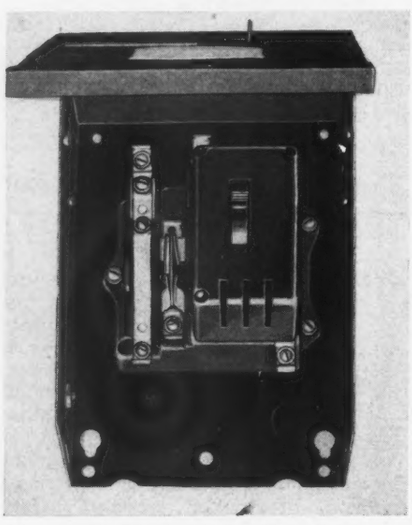
Square D Meter Service Breaker

FROM the Detroit, Mich., headquarters of the Square D Company comes the announcement of a Square D Meter Service Breaker. The announcement states in part: "Absence of fuses in the Square D Meter Service Breaker does away with the problems of sealed main fuses, accessible fuses, and interlocking doors.

"Front manual operation permits the breaker to be banked more closely, and recessed. Its quick make-and-break banishes contact burning and variable action. Its front operating handle is fully insulated, and no operator can receive a shock through it.

"The handle indicates the "on," "off" and "tripped" positions and can be locked or sealed in the "off" position. It is toggle-operated and can be reset as easily as an ordinary toggle switch can be operated.

"The box of the Service Breaker is of the usual size. Arrangement is made for ordinary meter trims and for banking troughs. There is a special bolt for locking the meter trims in place."



Square D Meter Service Breaker

Boston Compound Worm-Type Reducer

A SERIES of compound vertical speed reducers, known as Type "V-W," has been placed on the market by the Boston Gear Works Sales Company, Norfolk Downs, Quincy, Mass. These reducers are made in four sizes

Boston Type V-W Vertical Speed Reducer

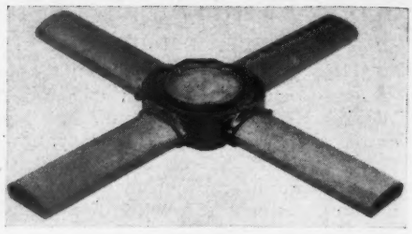
to accommodate very high reductions, being capable of reductions up to 4,000 to 1.

Hardened and ground steel worms and phospher bronze worm gears are used. The speed reducers are equipped throughout with tapered roller bearings to take care of the thrust.

G. E. "Fiberduct"

THE General Electric Company, Merchandise Department, at Bridgeport, Conn., has announced a non-corrosive raceway for under-floor wiring in concrete floors, known as "Fiberduct." This system is so designed that neat appearing outlets may be installed safely and economically at any point, and at any time during the life of the building.

Fiberduct is composed of impregnated fiber which, it is claimed, successfully resists corrosion. The wall thickness is 3/16 in. and the cross sectional area is 3 sq. in. The duct is oval in shape, so designed that when



G. E. Fiberduct

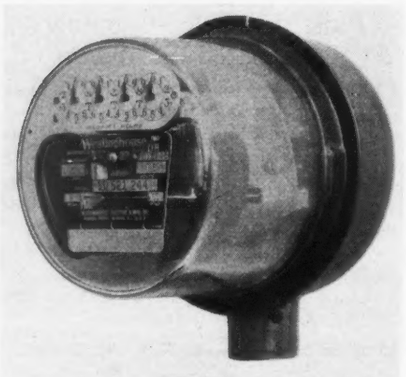
concrete is poured over it an arch is formed, thus assuring maximum strength. This shape offers the added advantage of minimum height, making it ideal for use where space between floors is limited.

Another feature of this new system is the cast iron, rust-resisting junction box equipped with an adjustable brass cover. A line of brass surface fittings permits outlets to be established when and where they are required. This system is adapted equally well for cinder fill or monolithic (one layer) construction.

Westinghouse OB Detachable Watthour Meter

CONSISTING of the standard, temperature-compensated OB watthour meter housed in an iron-clad weather- and tamper-proof case this instrument, offered by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., is suitable for mounting either in or out of doors.

An adjustable terminal block permits mounting the meter with conduit entrance at the top, bottom, right or left.



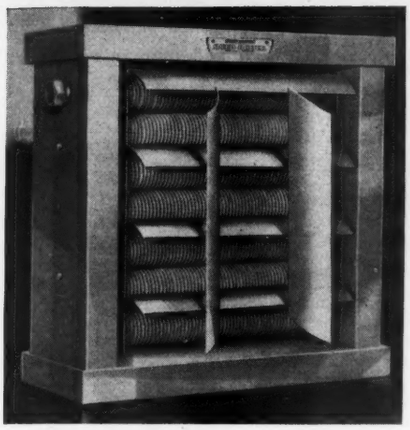
Westinghouse OB Detachable Watthour Meter

By means of plug terminals the detachable meters may be connected or removed in a moment like radio tubes.

Sturtevant Unit Heater

TO its line of unit heaters the B. V. Sturtevant Company, Berkeley, Calif., has added the Speed Heater.

There are three types in this line, Type 1, 2 and the Cabinet Heater, each having a two-speed motor. Type 1 op-



Sturtevant Speed Heater

erating at 750 and 950 r.p.m., Type 2 operating at 870 and 1,170 r.p.m. and the Cabinet Heater at 350 and 750 r.p.m. They are equipped with high-pressure Aerofin radiators. Steam pressure up to 250 lb. may be used. However, the heating elements work equally well on low-pressure steam.

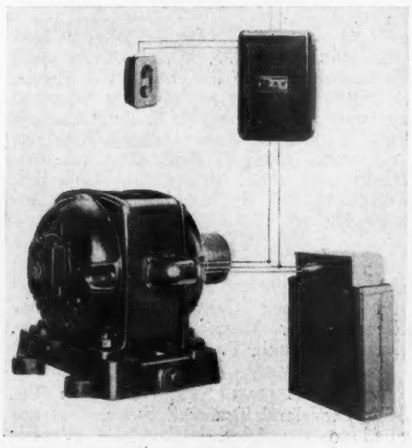
Vertical louvers are provided to break up the air flow by spreading it over a wider area. All types are provided with hangers.

G. E. Single-Phase Capacitor Motors

THE General Electric Company announce a line of single-phase, squirrel-cage capacitor motors, designated Type KC, especially designed for quiet operation in driving blowers and ventilating fans in buildings; on low-torque centrifugal machinery; on low-pressure pumping applications; on some wood-working machines, and on machine tools where the motor is built into the machine.

Although the motor is classified as a single-phase machine it is a modified two-phase, squirrel-cage motor with a capacitor in series with one phase of the stator windings. It has starting characteristics similar to the two-phase squirrel-cage motor; that is, it is self-starting. The capacitor remains in the circuit throughout starting and running so that full-voltage hand or magnetic control only is required.

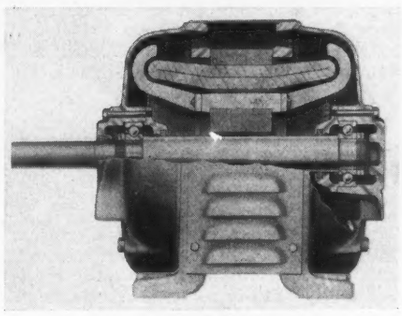
Available ratings in the line are from 1 to 25 hp., inclusive, at 3,600, 1,800, 1,200 and 900 r.p.m. constant speed, with starting torque from 60 to 40 per cent of full-load running torque depending upon speed. Maximum torque is approximately 200 per cent of full-load running torque.



G. E. Motor Connected to Capacitors and Control Devices

U. S. Turbo-Pump Motor

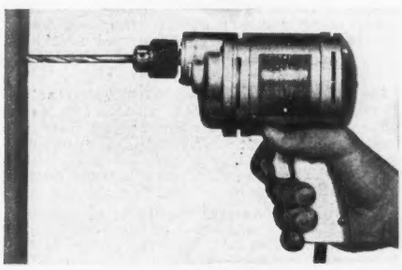
THE U. S. Electrical Manufacturing Company, 200 East Slauson Ave., Los Angeles, Calif., has developed a motor housing which will be known as the U. S. Turbo-Pump Motor. It is designed as an integral part of the pump, all operating parts of which are fully protected.



U. S. Turbo-Pump Motor

Clark No. 000 U "Wonder" ¼-In. Electric Drill

A DRILL that is suitable for work in close quarters has been placed on the market by the James Clark, Jr., Electric Company, 600 Berman St., Louisville, Ky. The drill is 7½ in. in length, and weighs 4½ lb. It has a no-load speed of 2,000 r.p.m. and a full-load speed of 1,200 r.p.m. Ball bearings are used throughout.

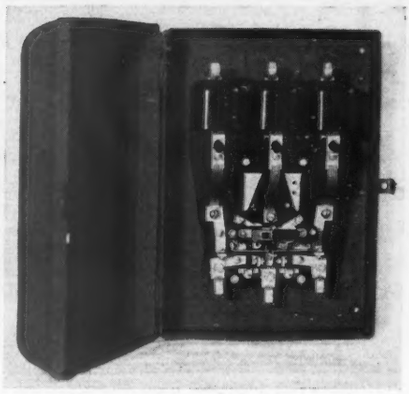


Clark No. 000 U Wonder ¼-In. Electric Drill

Diamond Heavy-Duty Magnetic Switch

SERIES KYR, designates the heavy-duty magnetic switch made by the Diamond Electrical Manufacturing Company, 1318 East Sixteenth St., Los Angeles, Calif., as a supplement to the KXR switch designed this year.

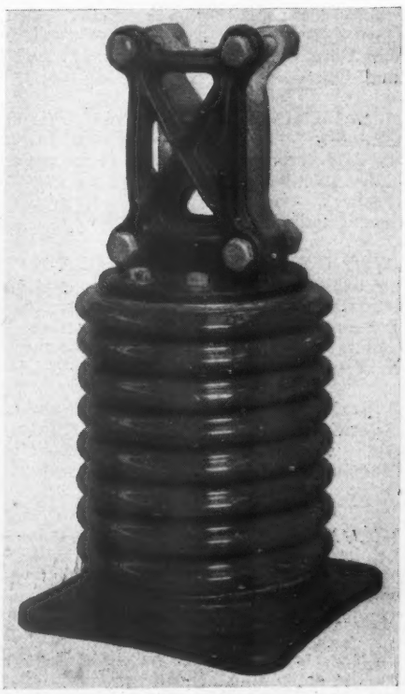
Special features include: Interchangeable thermal elements; entire bakelite panel assembly removed by loosening four screws; no control wires to disconnect; ample wiring space; concentric knockouts on four sides and back, and blowout coils furnished for higher ratings.



Diamond Heavy-Duty Magnetic Switch

Champion Heavy-Duty Bus Supports

THE Champion Switch Company, Kenova, W. Va., announces an improved line of bus supports with cantilever strengths up to 10,000 pounds. The porcelain units are made in several diameters and heights and are provided with fittings for all types and sizes of conductors. The supporting base is made of heavy pressed steel.



Champion Heavy-Duty Bus Supports

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(303) HEATING SYSTEM—A new booklet describes the Hot-Kold system of unit heating.—The General Iron Works Company, Cincinnati, Ohio.

(304) INSULATORS—Circular 1858, "Westinghouse Apparatus Insulators." Information and test data on the complete line.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(305) ENGINEERING BULLETIN SERVICE—Revision of several pages, bulletin No. 191-F.E., and revised table of contents.—Engineering Department, The New Departure Manufacturing Company, Bristol, Conn.

(306) ELECTRIC HEATERS—Bulletin C-108A, strip and space heaters, and complete air heaters.—Edwin L. Weigand Company, 7500 Thomas Blvd., Pittsburgh, Pa.

(307) OIL CIRCUIT BREAKERS—Leaflet GEA-974B, Type FKR-55 Oil Circuit Breakers, 7,500 to 15,000 volts, 600 to 3,000 amp., triple-pole, single-throw.—General Electric Company, Schenectady, N. Y.

(308) WELDED PIPING—Bulletin 105, "Pipe Welding with stock fittings in the new power plant at the Bureau of Standards, Washington, D. C."—Tube-Turns, Inc., Louisville, Ky.

(309) DISK GRINDERS—Form 3002, "Van Dorn Portable Flex-Disk Grinders."—The Van Dorn Electric Tool Company, Cleveland, Ohio.

(310) UNDERVOLTAGE DEVICES—Form GEA-1105A, Types HE-1, PF-2, PG-1, and MG-2 under-voltage devices for manually- and electrically-operated oil circuit breakers.—General Electric Company, Schenectady, N. Y.

(311) TURBINES—Bulletin GEA-1145, mechanical-drive turbines for operating centrifugal pumps, paper machines, compressors, fans, and similar machines.—General Electric Company, Schenectady, N. Y.

(312) ARC WELDER—Specification sheets covering the Lincoln 300-amp. "Stable-Arc" welder in its various sizes.—The Lincoln Electric Company, Cleveland, Ohio.

(313) TRUCK-TYPE SWITCHBOARDS—Leaflet D.M.F. 5192, Truck-type switchboards in various applications.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(314) OXWELDED PIPING—A 24-page booklet containing helpful and instructive information on the installation of Oxy-Acetylene welded piping for industrial uses, and also for the heating of industrial and domestic buildings.—Linde Air Products Company, 30 East 42nd St., New York, N. Y.

(315) BUS-BAR SUPPORTS—Circular 1825, Type H Bus-bar supports for indoor usage. A complete list of the different kinds and sizes rated at 7,500, 15,000, and 25,000 volts.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(316) WELDED PIPING—Bulletin 104, "Pipe Welding with stock fittings in the process industries."—Tube-Turns, Inc., Louisville, Ky.

(317) OUTDOOR SWITCHES—Circular 1861, Westinghouse outdoor switchhouses with manual-, motor-, or solenoid-operated oil circuit breakers.—Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(318) TURBINE GENERATOR SETS—Leaflet GEA-1130, turbine-generator sets, direct-current, 10 to 300 kw.—General Electric Company, Schenectady, N. Y.

(319) TANK RHEOSTATS—A leaflet describing Columbia cast-grid tank rheostats, 400- to 3,200-amp. capacity.—Columbia Electric Manufacturing Company, 1292 East 53rd St., Cleveland, Ohio.

Coming Events

American Society of Heating and Ventilating Engineers—35th annual meeting, Jan. 27 to 30, 1930; Hotel Benjamin Franklin, Philadelphia, Pa.

International Heating and Ventilating Exposition—To be held under the auspices of the American Society of Heating and Ventilating Engineers, Commercial Museum, Philadelphia, Jan. 27 to 31, 1930. Manager, Charles F. Roth, Grand Central Palace, New York.

National Industrial Equipment Exposition—The first national industrial equipment exposition will be held in the Hotel Stevens, Chicago, March 3 to 7, 1930. Management, Midwestern Engineering Exposition, 308 West Washington St., Chicago, Ill.

American Society of Mechanical Engineers—Fiftieth Anniversary, April 5-9, 1930. New York, Hoboken and Washington.

American Society of Mechanical Engineers — Materials-Handling Meeting, April 5 to 9, 1930. Hotel Stevens, Chicago, Ill.

American Society of Mechanical Engineers—Semi-annual meeting of the Society, June 9 to 12, 1930. Hotel Book-Cadillac, Detroit, Mich.

National Electric Light Association—Annual Convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

(320) "ISOLATION"—A publication devoted to the scientific, practical, and economical application and study of materials and methods of deadening and eliminating vibration and noise.—The Korfund Company, Inc., 235 East 42nd St., New York, N. Y.

(321) RELAYS—Leaflet GEA-847, Induction Differential Relays, Types IJ-2, IJ-3, IJ-5, IJ-6, IJ-7, IJ-8, and IJ-11.—General Electric Company, Schenectady, N. Y.

(322) MOTOR MAINTENANCE EQUIPMENT—Catalog B-829, Ideal motor maintenance equipment and electrical specialties.—Ideal Commutator Dresser Company, Sycamore, Ill.

(323) BLOWERS—Catalog, Rotary positive blowers, gas exhausters and blowers, displacement meters, vacuum and liquid pumps.—The Connorsville Blower Company, Connorsville, Ind.

(324) ELECTRIC WIRING—Catalog 2200 supersedes all previous listing of condulets, groundulets, plugs, and receptacles.—Crouse-Hinds Company, Syracuse, N. Y.

(325) PYROMETER—The Wilson-Maeulen potentiometer recording pyrometer is described in an 8-page illustrated booklet.—Wilson-Maeulen Company, 383 Concord Ave., New York, N. Y.

(326) STEEL ROOFING—16-page illustrated booklet "Erection Data and Specifications on Truscon Ferrobord Armco Ingot Iron Roofdeck."—Truscon Steel Company, Youngstown, Ohio

(327) VENTILATION—"Industrial Airation by the Fenestra method." A non-technical presentation of certain principles in ventilation developed by the Department of Engineering Research of the Detroit Steel Products Company and the Department of Engineering Research of the University of Michigan.—Detroit Steel Products Company, 2250 E. Grand Blvd., Detroit, Mich.

(328) UNIT HEATERS—16-page booklet describing the salient features of industrial unit heating.—Grinnel Company, Providence, R. I.

(329) WELDING—Bulletin 4 on Type S welding rod developed for welding 18-8 chrome-nickel and similar alloy steels.—Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill.

(330) ROLLER CHAIN—Roller Chain Data Book, No. 1257, 96 pages illustrating the construction of the chains and wheels, including many pages showing practical applications of Link-Belt Roller Chain on light and heavy-duty industrial drives, and on all types of machinery, tractors, trucks and other equipment.—Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill.

(331) GEARS—Folder 5223, "It Pays to Use Westinghouse-Nuttal Heat-Treated and Hardened Gears."—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(332) TRAMRAIL SYSTEMS—Form TR. 3429, Cleveland Tramrail Systems as applied to foundries.—Cleveland Electric Tramrail Division of The Cleveland Crane and Engineering Company, Wickliffe, Ohio.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Symptoms and Causes of Motor Troubles and How to Remedy Them

TROUBLE SYMPTOMS	PROBABLE CAUSES	TESTS AND THE REMEDY
[A]—MOTOR WILL NOT START ITS LOAD		
Determine by inspection	1. No voltage at the motor terminals. 2. Low line voltage. 3. Fuses blown (See E). 4. Poor contacts or connections. 5. Brushes not set properly. 6. Motor connected to the wrong power circuit (See K). 7. Motor terminals not properly connected to the power circuit. 8. Service lines or transformer, or both, too small. 9. Motor overloaded. 10. Shorted, grounded or open windings (See J, K and L). 11. Worn bearings allowing the rotating part to drop down on the stationary field.	1. See if lights on the same circuit burn or connect test lamp across motor terminals with motor switch closed. 2. Check voltage. If abnormal voltage drop in service lines, rewire circuit with larger wire. 3. Check size and condition of fuses. 4. Examine and tighten all loose connections. 5. See that brushes seat well on the commutator and are free to move in their holders. Check the brush setting. 6. Check nameplate data. 7. Check motor line connections. 8. Check transformer. (Also see No. 2 above.) 9. Check speed. An overload usually causes the speed to drop below nameplate marking. 10. See J, K and L. 11. Inspect bearings for tightness and lubrication.
[B]—MOTOR SEEMS TOO WEAK—RUNS SLOW		
Determine by inspection	1. Low voltage at motor terminals. 2. Motor overloaded. 3. Poor contacts or connections. 4. Motor connected to the wrong power circuits. 5. Motor improperly connected to circuit. 6. Motor windings damaged (See J, K and L).	1. See A-2. 2. Remove load. If motor operates at rated speed check bearings for tightness and lubrication. 3. Check all contacts at main switch or auxiliary switches used to operate motor. Clean commutator and make sure that the brushes are free in holders. 4. See A-6. 5. See A-7. 6. See J. K and L.
[C]—MOTOR RUNS TOO FAST		
Check speed	1. High voltage. 2. Motor connected to wrong circuit. 3. Motor terminals improperly connected to circuit. 4. Frequency too high (a.c. motors only). 5. Motor windings damaged (See J, K and L).	1. Check voltage on line. 2. See A-6. 3. See A-7. 4. Determine frequency stamped on motor nameplate and check with power source. 5. If d.c. motor test for open shunt field circuit. 6. See J, K and L.
[D]—MOTOR RUNS TOO HOT		
Determine by thermometer reading SYMPTOMS: Distinct odor of burning insulation	1. Motor overloaded during starting and running period. 2. Line voltage too high. 3. Line voltage too low. 4. Belt too tight or coupling or gear out of line. 5. Insufficient lubrication. 6. Faulty commutation (See F). 7. Motor windings damaged. 8. One fuse blown in two- or three-phase motor circuit allowing motor to operate on one phase (single phase).	1. Remove load, run motor idle. Give it a general inspection. Apply load gradually and note characteristics. Inspect for localized heating. 2. See C-1. 3. See A-2. 4. Adjust belt, gear or coupling. 5. See I. 6. See F-2. 7. See J, K and L. 8. If trouble not eliminated check windings for defects (See J, K and L).

Courtesy of Master Electric Company, Dayton, Ohio.

INDUSTRIAL ENGINEERING'S DATA SHEETS

TROUBLE SYMPTOMS	PROBABLE CAUSES	TESTS AND THE REMEDY
[E]—MOTOR FUSES BLOW		
Determine by inspection SYMPTOMS: (a) Motor stops. (b) Motor gets hot. (c) Motor refuses to start.	1. Motor overloaded. 2. Fuse too small. 3. Motor connected to wrong power circuit. 4. Motor improperly connected to circuit. 5. Damaged motor windings.	1. See D-1. 2. Check fuse information sent with the motor. 3. See A-6. 4. See A-7. 5. See J. K and L.
[F]—FAULTY COMMUTATION		
SYMPTOMS: (a) Excessive flashing. (b) Blackened commutator. (c) Brushes wear rapidly.	1. Protruding mica or rough commutator. 2. Dirt or oil on commutator. 3. Brushes stuck in holders. 4. Wrong brush position. 5. Weak springs. 6. Overloaded motor. 7. Motor windings damaged.	1. Remove armature and have a thin cut taken off the commutator with sharp lathe tool. 2. Clean commutator with a soft rag. 3. Make sure brushes ride easily in their holders. 4. See A-5. 5. Replace springs. 6. See A-9. 7. See J, K and L.
[G]—EXCESSIVE BRUSH WEAR		
Determine by inspection One set of brushes should function satisfactorily for at least 2,500 running hours.	1. Excessive sparking or flashing at the brushes. 2. Wrong quality brush. 3. Rough commutator or high mica between the commutator bars. 4. Overloads.	1. Inspect condition of commutator, also brush spring tension. 2. Replace brushes to insure proper commutation. 3. If mica segments protrude take a thin lathe cut from commutator. Polish with No. 00 sandpaper. Use no oil. 4. See A-9, and D-1.
[H]—MOTOR IS NOISY		
Determine by inspection	1. Worn bearings (See I). 2. Rough commutator or high mica between bars. 3. Unbalanced armature. 4. Brushes fit too loosely in the holder. 5. Armature out of center. 6. Insufficient end play. 7. Excessive end play. 8. Air gap not uniform. 9. Loose accessories such as condulet box, guards, etc. 10. Motor mounted on foundation that is not solid or that vibrates when motor is running. 11. Bearings not properly assembled. 12. Motor out of alignment (coupling or gear drive only).	1. See I. 2. See F-1. 3. Return complete motor to factory for correction or replace with spare armature. 4. Replace brushes. 5. Ship motor to factory for correction. 6. Oil thoroughly. 7. If end play exceeds 0.010 in. on ball bearings or 1/32 in. on sleeve bearings tighten adjusting nuts. 8. Replace the bearings. 9. See that end covers, guards, etc., are tight. 10. Make sure that motor is properly fastened to its foundation. 11. Make sure that adjusting nuts are tight. If ball bearings (1) remove dust caps (2) tap races to see if properly seated. 12. Loosen motor foot bolts and re-align with driven machine.
[I]—WORN BEARINGS		
Determine by inspection SYMPTOMS: Excessive noise. Excessive vibration. Rotor striking field.	1. Insufficient lubrication. 2. Wrong kind of lubrication. 3. Belt too tight. 4. Coupling or gear out of line. 5. Excessive end play.	1 and 2. Replace bearings and lubricate thoroughly. 3. See that belt is just tight enough to prevent slipping during starting and running periods. 4. See H-12. 5. See H-7.
[J]—GROUNDED FIELD OR ARMATURE		
Grounded field—Determine by using series lamp or magneto test from motor leads to frame. Grounded armature—Test from shaft to commutator. SYMPTOMS: Loss of power. Slow speed.	1. Copper dust. 2. Oil or dirt on brush-holder parts or where coils enter the slots in the field. 3. Defective insulation. 4. Mechanical damage to insulation in handling. 5. Over-heating sufficient to char the insulation. 6. Damaged winding.	1. Remove all oil, dust or dirt from the motor. 2. Look for bare wires near end cover bolts, end of the slots, or where leads are soldered. 3. Wipe commutator with dry rag. 4. Clean mica between commutator bars. 5. On Type RA, single-phase motors, if segments touch the commutator the armature will be grounded. 6. If the windings are making direct contact with the frame reinsulate thoroughly.

INDUSTRIAL ENGINEERING'S DATA SHEETS

TROUBLE SYMPTOMS	PROBABLE CAUSES	TESTS AND THE REMEDY
[K]—SHORT-CIRCUITED FIELD OR ARMATURE		
Armature short-circuited in a.c. motor. The shorted coil will center under the stator coil and become excessively hot. If d.c. motor, it will operate at speeds below normal for all loads and the shorted coil will get very hot.	1. Solder between commutator bars where armature leads are connected. 2. Damaged winding.	Regardless of cause proceed as follows: 1. Inspect the soldering of the commutator leads to see that solder does not touch any two commutator bars at the same time. 2. If windings have been damaged and two bare wires are touching each other, reinsulate with varnished cloth or tape. 3. If trouble is not removed by (1) and (2) return the motor direct to the factory for repairs.
[L]—OPEN-CIRCUITED FIELD OR ARMATURE		
SYMPTOMS: 1. Burnt mica between bars nearest open circuit. 2. Excessive sparking around commutator. 3. Refusal to start at certain portions of the armature. 4. Failure to start generally accompanied by a humming sound when motor line switch is thrown on.	1. Broken wires. 2. Defective soldering. 3. Damaged winding. 4. Lead wires disconnected. 5. Commutator leads loose.	1. Examine line fuses to make sure they have not blown. This is especially important with two or three-phase motors. 2. See that the motor is properly connected to the line. 3. If a broken wire is apparent make the repair and reinsulate the splice with friction tape. 4. Check point where motor leads connect to the winding. 5. Resolder any loose commutator leads. If open circuit cannot be located return to factory for repair.
[M]—IMPROPER CURRENT SUPPLY		
SYMPTOMS: 1. Motor overheats. 2. Motor is noisy. 3. Refuses to start. 4. Line fuses blow.		Replace the motor with one built for operation on the local power circuit.
[N]—WORN BRUSHES		
SYMPTOMS: 1. Motor refuses to start. 2. Motor not up to normal speed.	1. Overload. 2. Natural wear. 3. Rough commutator.	1. See A-9. 2. Replace with new brushes. Fit the new brushes to the curvature of the commutator. 3. Polish the commutator with sandpaper (never use emery paper) or take small cut off in a lathe.
[O]—MOTOR TOO SMALL		
Determine wattage input under load SYMPTOMS: 1. Will not come up to speed under load. 2. Excessive or continuous sparking.		1. Check speed when testing for wattage input. 2. Relieve part of the load or use a larger motor.
[P]—STICKING BRUSHES		
SYMPTOMS: 1. Motor turns but will not always start. 2. Excessive flashing at the commutator.	1. Presence of dirt or foreign matter in brush holder. 2. Rough spots on brushes. 3. Brush tension spring incorrectly applied.	Press down on brushes. If motor starts remove brushes, clean out holders and sand with No. 00 sandpaper. Also sand the commutator.
[Q]—BRUSHES NOT MAKING CONTACT		
SYMPTOMS: 1. Loss of power. 2. Excessive sparking. 3. Refusal to start.	1. Brush spring tension weak. 2. Brush spring not in proper position. 3. Brushes not properly sanded.	1 and 2. Correct brush spring position or replace with new springs. 3. Sand the brush until it conforms to the commutator curvature.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Carbon Brush Maintenance and Trouble Chart

An Analysis of Causes and Effects of Brush and Commutator Troubles in D. C. Motors and Generators

CAUSES OF BRUSH AND COMMUTATOR TROUBLES		EFFECTS AND EVIDENCES OF TROUBLES															
		Sparking	High Mica	Flat Spots	Commutator Heating	Armature Heating	Black Commutator	Rapid Commutator Wear with Commutator Black	Rapid Commutator Wear with Commutator Bright	Pitting of Brush Faces	Glowing of Brushes	Picking Up Copper	Noisy Brushes	Loosening of Brush Shunts	Rapid Brush Wear	Burning of Brush Holder Boxes	Loss of Temper in Brush Springs
	1 Sparking*		√	√	√		√	√							√		
ARISING FROM WRONG GRADE OF BRUSH	1 Too low carrying capacity				√		√			√	√				√		
	2. Too little abrasive action		√		√		√										
	3. Too much abrasive action				√				√				√		√		
	4. High friction brushes				√								√				
	5. Too high contact drop	√			√												
	6. Too low contact drop	√			√	√	√			√	√				√		
DUE TO FAULTY BRUSH OPERATION	1. Brushes off electrical neutral	√			√	√				√	√	√					
	2. Incorrect brush spacing	√			√	√				√				√			
	3. Brushes too thick	√			√	√				√	√	√					
	4. Brush pressure too low	√	√		√		√	√		√	√				√		
	5. Brush pressure too high				√				√				√		√		
	6. Unequal brush pressure	√								√	√			√			
	7. Brushes tight in holders	√	√	√			√	√		√	√				√		
	8. Worn brush holders on machines running in only one direction													√		√	
	9. Worn brush holders on reversing motors	√								√	√		√	√	√	√	√
	10. Brushes operated at wrong angle												√				
	11. Brushes chattering	√	√		√								√	√	√		
	12. Too high ratio of brushes to commutator surface				√												
	13. Lubricated brushes						√										
	14. Loose brush shunts															√	√
	15. Loose terminal screws															√	√
ARISING FROM COMMUTATOR DEFECTS	1. Brush studs not parallel to commutator bars	√			√	√				√	√			√			
	2. High mica	√		√	√		√	√					√		√		
	3. High bar	√		√									√		√		
	4. Low bar	√		√													
	5. Eccentric commutator at high speed	√		√													
	6. Rough commutator				√										√		
	7. Use of lubricant on commutator				√		√					√					
	8. Dirty commutator				√												
	9. Difference in hardness of bars			√													
	10. Difference in hardness of mica			√													
	11. Commutator not properly finished after turning				√										√		
	12. Commutator too small				√												
CAUSED BY ARMATURE AND FIELD DEFECTS	1. Loose end connection	√		√													
	2 Open circuit in armature coil	√		√													
	3. Unbalanced armature winding	√		√	√	√											
	4. Mechanically unbalanced armature	√		√													
	5. Jammed armature laminations					√											
	6. Partial short in shunt field	√															
	7. Series field poorly adjusted	√	√		√	√											
	8. Series field bucking	√	√		√	√											
	9. Poor adjustment of interpoles	√	√		√	√											
	10. Unequal air gaps	√			√	√											
	11. Worn bearings	√			√	√											
	12. Flux distribution	√			√	√											
FROM EXTERNAL SOURCES	1 Overloads	√			√	√								√			
	2. Surges of load on line			√													
	3. Cross currents between generators	√		√	√	√				√				√			
	4. Poor belt lacing			√													
	5 Pound of engine			√													
	6. Unstable foundation	√		√													

*Sparking is the effect of some other trouble, but at the same time it is the immediate cause of so many other troubles that it has been shown among the causes of commutator troubles.

Courtesy of The Martindale Electric Company, Cleveland, Ohio.

INDUSTRIAL ENGINEERING

A McGraw-Hill Publication

PLANT ENGINEERING In Industry

DECEMBER, 1929

Raw Stock To Shipment-On Timkens

In the Jeannette, Pa., tire plant of the Pennsylvania Rubber Company 4000 feet of Timken-equipped Palmer Bee conveyors handle every bit of material, from raw stock to finished tires. The installation is a striking example of how modern methods can cut costs and increase production.

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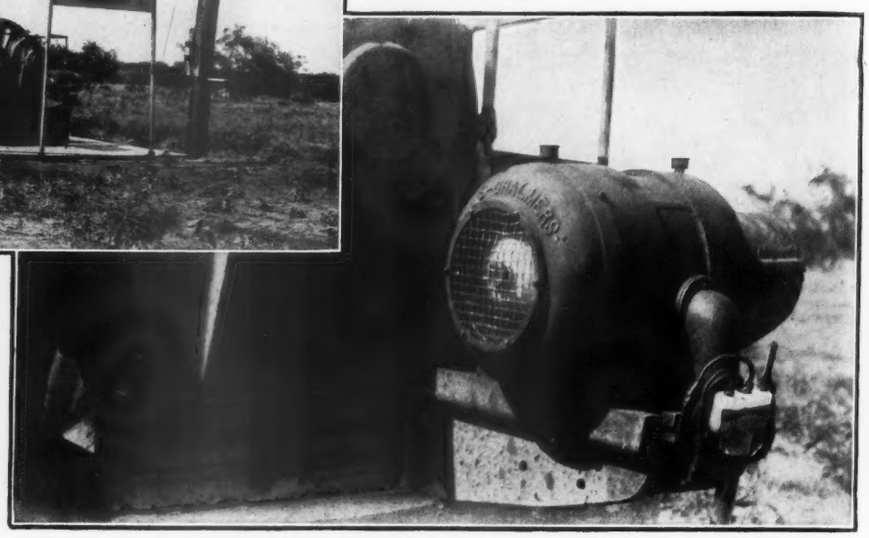


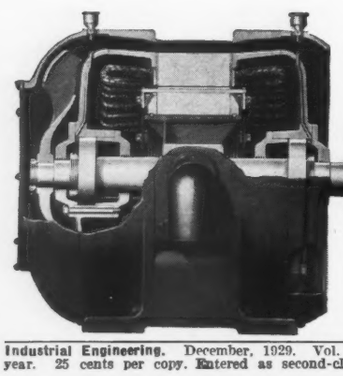
Rain and Dirt Cannot harm this motor

Allis-Chalmers Totally Enclosed Fan-Cooled Motors may be installed almost anywhere without any extra protection. Rain, dust, sand, gases — none of them can harm this motor. They cannot get into the interior of the motor or the bearings. A glance at the sectional view below will show how this protection is obtained.

The windings are enclosed by solid cast iron bearing housings that are attached to the stator end heads with a machined fit, and carry the grease packed bearings. This is a simple and sturdy construction, with no rubbing or revolving seals, making the windings readily accessible and giving extra strength to the motor.

Standard sizes from 2 to 40 H. P.

Totally Enclosed Fan-Cooled Motors are intended for severe service where the installation of open type motors is not practical as in dusty or gaseous locations or where there is danger of oil soaked windings.



ALLIS-CHALMERS

Totally Enclosed Fan-cooled MOTORS

Industrial Engineering. December, 1929. Vol. 87. No. 12. Published Monthly. McGraw-Hill Publishing Company, Inc., 520 N. Michigan Ave., Chicago, Ill. $2 per year. 25 cents per copy. Entered as second-class matter Feb. 25, 1929, at the postoffice at Chicago, Illinois, under Act of Congress of March 3, 1879. Printed in U. S. A.

INDUSTRIAL ENGINEERING

Founded in 1882 as Electrical Review. Consolidated with it—Western Electrician and Industry Illustrated.

Plant Engineering in Industry

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WILBUR A. BECK, *Managing Editor* G. A. VAN BRUNT, *Electrical Editor* WILLIAM STANIAR, *Consulting Transmission Editor*
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Volume 87, Number 12

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LAYING out a distribution system for a large plant is a man-sized job. Hence Timken's practices in distributing large blocks of power, outlined on page 604, may save you time and money in planning a new system or revamping the old one.

BUDGETS to most of us are old stuff, but when they are applied to upkeep they become news. If you haven't a definite policy of upkeep there's plenty of news in B. A. Franklin's article on page 622.

ONLY by comparison does one problem become more complicated than another. Ray G. Rech, on page 614, provides data that can be used for comparison in estimating your materials-handling problem.

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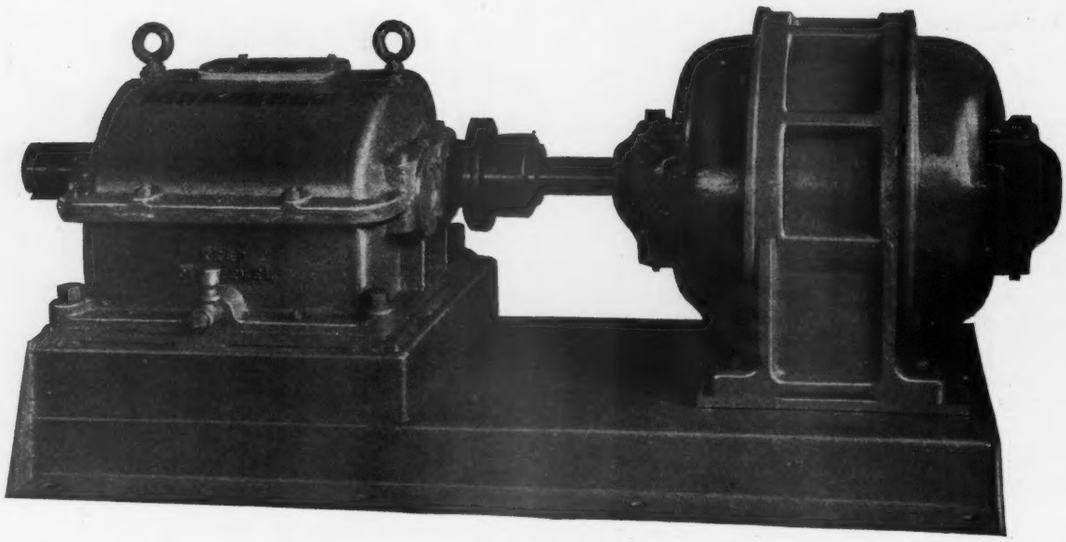

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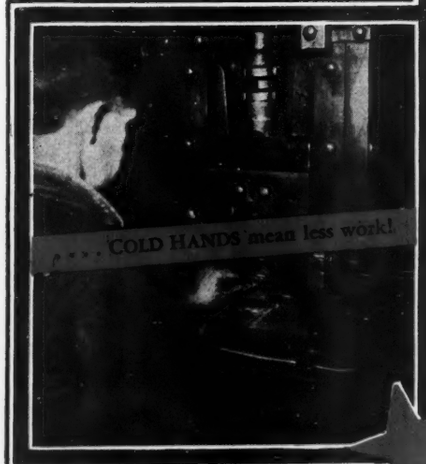

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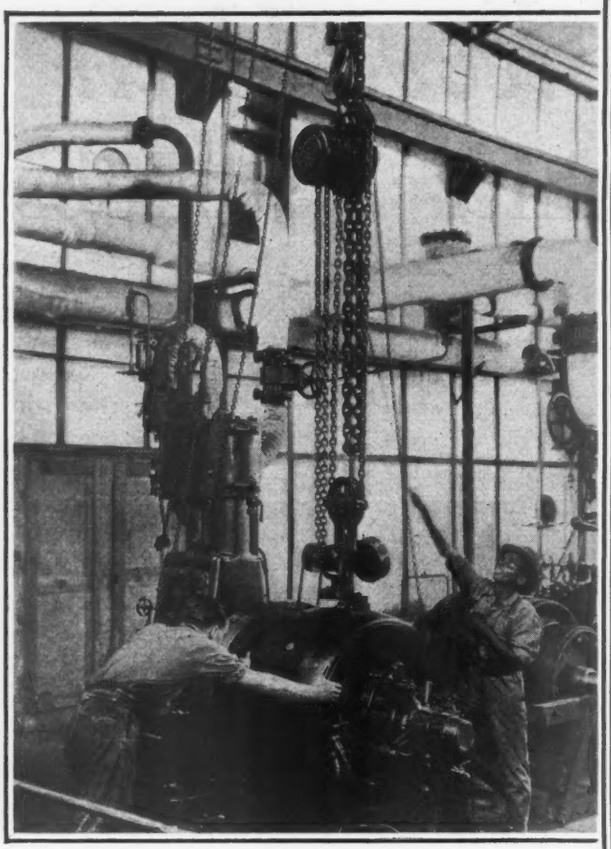

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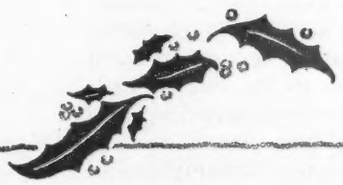

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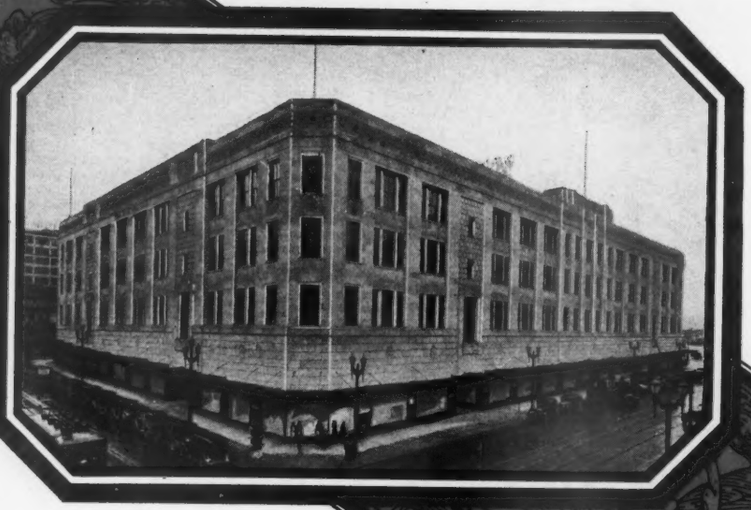

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Send for the Jeffrey Trolley Conveyor Catalog No. 476-G.

This Toggle Reduces Maintenance

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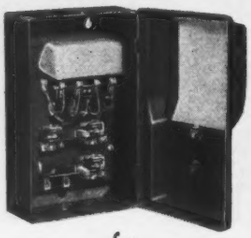

for

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Bulletin 719 Oil Burner Control Panel operates in conjunction with oil burner safety shunting controls where these controls lack sufficient capacity to switch motor current.

The magnetic switch starts motor when thermostat makes contact, if pressure switches, low water gauges, etc., are closed. If oil burner fails to ignite, temperature relay opens switch and stops motor. Overload protection also can be provided.

Ratings: — Single Phase — 1½ H. P., 110 V.; 3 H. P., 220 V. Polyphase—3 H. P., 110 V.; 5 H. P., 220 V. 7½ H. P., 440-550 V. Steel cabinet can be locked to prevent tampering.

BULLETIN 719

for

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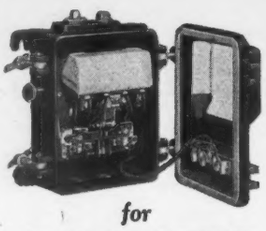
Bulletin 707 Single Phase Starting Switch is a double-pole magnetic switch with maximum rating of 1½ H. P., 110 V.; 3 H. P., 220 V., 25 to 60 cycles, for motors operating refrigerating machines, compressors, pumps, oil burners and other devices governed by 2-wire or 3-wire pilot controls. Switch coil has double winding, permitting switch to be used interchangeably up to and including 1½ H. P., for 110 or 220 V. motors by changing coil connections.

A Resisto-therm Overload Relay provides accurate and reliable overload protection.

BULLETIN 707



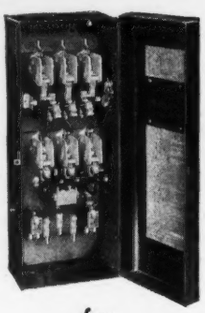
for

SPLASH-PROOF SERVICE

Bulletin 709WT Splash-proof Switches are standard Allen-Bradley Bulletin 709 Across-the-Line Switches enclosed in cast iron splash-proof cabinets. These switches are ideal for laundries, creameries, packing plants, rayon plants, and other factories requiring splash-proof switches. They also are suitable for dusty installations such as found in flour mills, cement plants, etc. Special splash-proof start-and-stop buttons and relay reset buttons are provided and the hinged cover has a rubber gasket to exclude spray and moisture.

These switches are rated for single phase motors up to 3 H. P., 110 V.; 5 H. P., 220 V., and for polyphase motors up to 5H. P., 220 V., and 7½ H. P., 440-550 V.

BULLETIN 709WT



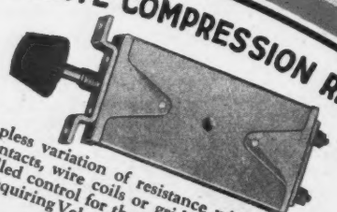
for

AUTOMOBILE PLANTS

Bulletin 711-712 Across-the-Line Starting Switches have outside-operated disconnect switches and separate test jacks. Fuse Clips can be provided. These switches eliminate much wiring and conduit, and permit easy rearrangements of motors and starters when plant layout changes are necessary. Test jacks provide safe means for determining motor load. Ratings up to 10 H. P., 110 V.; 30 H. P., 220 V.; 60 H. P., 440-550 V.

BULLETIN 711-712
WITH DISCONNECT SWITCHES

GRAPHITE COMPRESSION RHEOSTAT



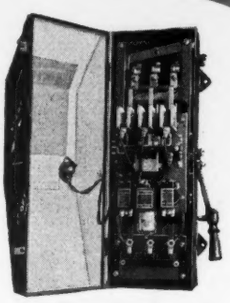
Stepless variation of resistance without sliding contacts, wire coils or grid resistors. Unrivalled control for thousands of applications requiring Velvet Smooth Current Control.

Allen-Bradley SETS THE PACE

NEW AUTOMATIC CONTROL

The automatic control devices, illustrated on these pages, are examples of specialized equipment. This new line demonstrates the ability of the Allen-Bradley Company to match the need with the correct control. The prestige of the Allen-Bradley trade-mark makes this line of automatic switches an asset alike to the machine builder and the factory superintendent.

Masters of industry look to Allen-Bradley for the unique and the new in control design.



for

SQUIRREL CAGE MOTORS

Bulletin 648 Resisto-Transformer Starter has graphite compression resistors in series with auto-transformer when starter is first connected to line. Resistors eliminate current inrush of ordinary starting compensator and prevent voltage fluctuation during starting. Motor is accelerated by steplessly reducing starting resistance. Ratings:—Up to 75 H. P., 220 V.; 125 H. P., 440-550 V., at 50 or 60 Cycles, and 30 H. P., 220 V., 50 H. P., 440-550 V., at 25 or 30 Cycles.

BULLETIN 648

for

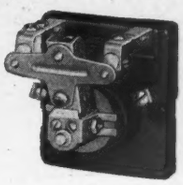
SMALL A.C. & D.C. MOTORS

Bulletin 825 Fractional Horse Power Overload Breakers are designed to protect small A. C. and D. C. Motors up to 1 H. P., 125 volts, and 1½ H. P., 250 volts, on refrigerating machinery, pumps, fans, machine tools, compressors, etc. Combinations have been developed for manual starting or for two-wire control, such as a pressure switch, float switch, etc. The maximum current rating is 15 amperes at 125 and 250 volts.

The contacts are silver plated, with arc barriers and magnetic blow-outs to assure ample current-interrupting capacity.

The overload breaker will accurately repeat its tripping operation on overload an indefinite number of times.

BULLETIN 825



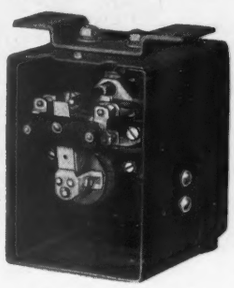
for

A. C. & D. C. SWITCHING

Bulletin 201 D. C. and Bulletin 701 A. C. Contactors are designed for electric ranges, water heaters, steam vulcanizers, fire alarms, oil burners, refrigerators, traffic signal systems, and other applications requiring small automatic single or double pole contactors. The current rating is 15 amperes for the double pole contactor and 30 amperes for the single pole contactor. The magnet coil can be wound for any standard voltage from six volts to 230 volts.

These contactors are available for two-wire separate control, 2-wire common control, and 3-wire pilot control. Silver contacts are used.

BULLETIN 201 D. C.
BULLETIN 701 A. C.



for

A. C. REVERSING SERVICE

Bulletin 704 Alternating Current Reversing Switch consists of two double-pole magnetic contactors, mounted back to back with an interlocking pin between them. When contactor on one side closes, it pushes interlocking pin against contactor arm of opposite switch. If opposite switch is already closed, interlocking pin cannot move and first contactor remains open.

Furnished for 2 and 3-wire control. Maximum rating 1 H. P., 110 V.; 1½ H. P., 220 V., single phase. 2 H. P., 220, 440, 550 V. polyphase.

BULLETIN 704

Bradley

IN CONTROL DESIGN

SEND FOR BULLETINS

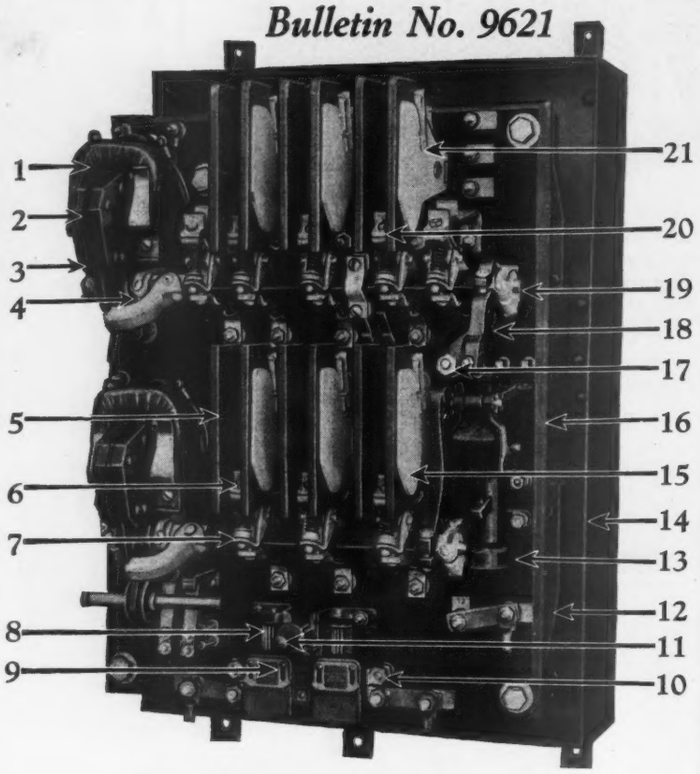
ALLEN-BRADLEY CO.
491 Clinton St., Milwaukee, Wis.

Send us bulletins describing new Automatic Switches for.....

Name.....

Address.....

Bulletin No. 9621



Built to a "Standard of Millions of Operations"

1 Magnet coil easily removed.

2 Double pull solenoid type magnet—quick positive pull.

3 Cushioned magnet construction assures long life.

4 Entire switch finger assembly easily removed as a unit.

5 New chimney type arc shields carry arc away from contacts to prevent pitting and burning.

6 Contacts easily removed for replacement or repair.

7 Individual switch fingers easily removed for replacement or repair.

8 Thermal overload relays cut motor from line only when temperature of windings becomes dangerous.

9 Thermal overload adjustment accurate to allow for maximum loading without danger to motor.

10 Thermal overload heater coils easily changed to make each starter suitable for wide range of motors.

11 Overload release easily reset from outside of case.

12 Entire mechanism complete on unit panel is supported by mounting straps—not by case.

13 Quick-reset, adjustable timing device gives accurate, consistent timing.

14 Split case design allows easy access to all parts of starter mechanism.

15 Heavy duty blow-out coils quickly snuff arc to protect contacts.

16 Ample capacity transformer has easily accessible taps to regulate starting current to 50%, 65% or 80% normal.

17 Timing adjustment made by simply turning this screw.

18 Mechanical and electrical interlocks insure that starting switch opens before running switch closes.

19 Switches operate on hardened and ground steel bearings.

20 Heavy tinned copper contacts have full roll-and-rub action. Cool operation insures long life.

21 Arc shields entirely removable without tools provides for their quick replacement or repair and allows easy access to contacts.

Tested in a phantom plant

—*where service is more severe than in any actual plant!*

THE service requirements of present-day mill or factory can never be as severe as the tests which C-H Starters undergo in this phantom plant . . . the Cutler-Hammer Testing Laboratories.

Here, Cutler-Hammer Starters are tested to a standard of millions of operations. Such parts as do not stand up heroically are redesigned, rebuilt, retested. Over and over again this process is repeated . . . until every weakness is hounded out, every flaw and imperfection corrected . . . until C-H Starters *pass* the test of millions of operations.

The 21 features listed on this page give you some idea of the rugged construction, the superior design and mechanism of the C-H Auto Transformer Starter. The same standards are found in all C-H Starters. And the reserve power which is built into them is simply a guarantee that their service in your plant will be entirely satisfactory over a *longer* period of years . . . reducing maintenance, repairs and depreciation.

Any additional information you may require will be sent at your request.

CUTLER-HAMMER, Inc.

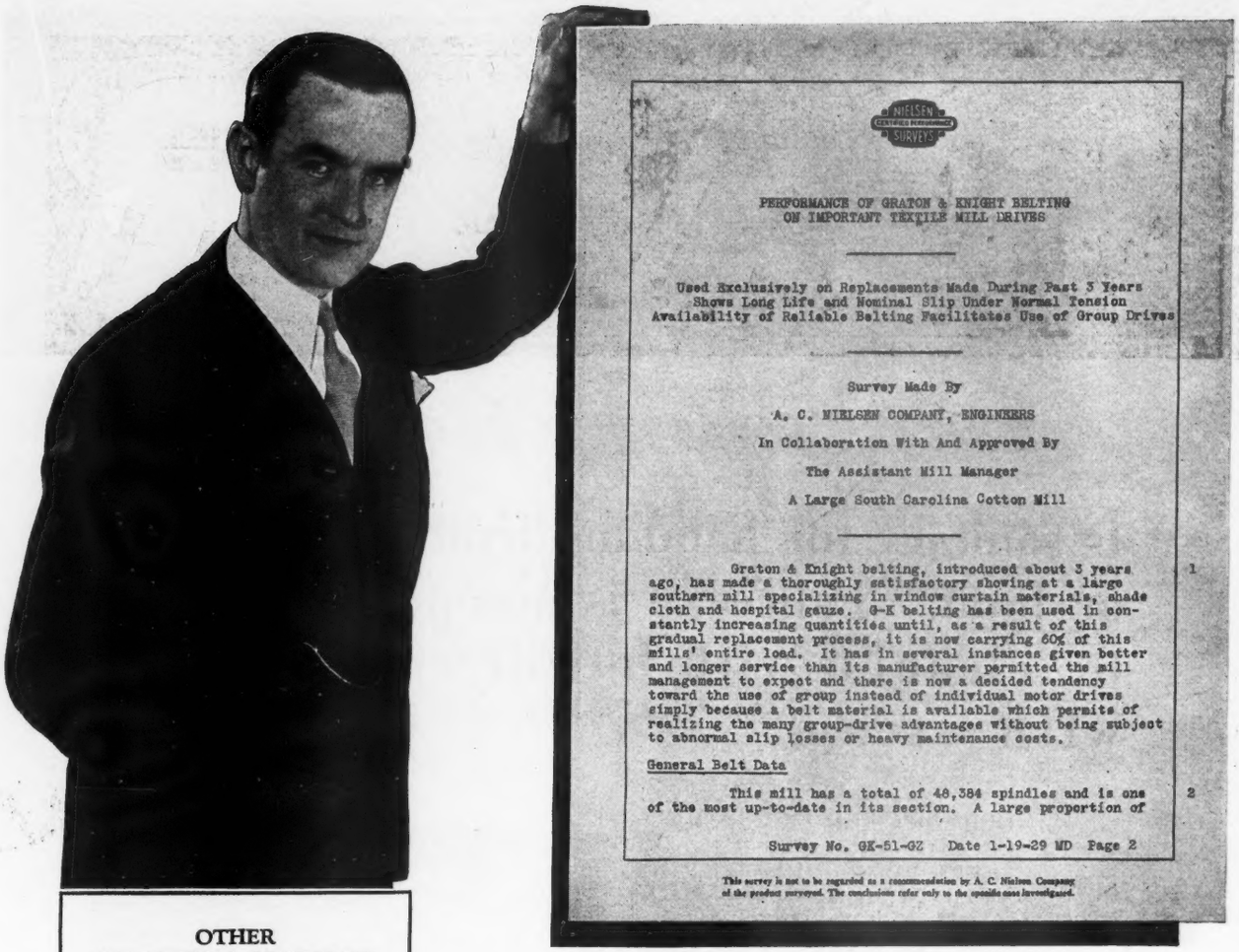
Pioneer Manufacturers of Electrical Control Apparatus

1205 St. Paul Avenue, MILWAUKEE, WISCONSIN

CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

(8609)


NIELSEN
SURVEYS
PERFORMANCE OF GRATON & KNIGHT BELTING
ON IMPORTANT TEXTILE MILL DRIVES
Used Exclusively on Replacements Made During Past 3 Years
Shows Long Life and Nominal Slip Under Normal Tension
Availability of Reliable Belting Facilitates Use of Group Drives
Survey Made By
A. C. NIELSEN COMPANY, ENGINEERS
In Collaboration With And Approved By
The Assistant Mill Manager
A Large South Carolina Cotton Mill
Graton & Knight belting, introduced about 3 years ago, has made a thoroughly satisfactory showing at a large southern mill specializing in window curtain materials, shade cloth and hospital gauze. G-K belting has been used in constantly increasing quantities until, as a result of this gradual replacement process, it is now carrying 60% of this mills' entire load. It has in several instances given better and longer service than its manufacturer permitted the mill management to expect and there is now a decided tendency toward the use of group instead of individual motor drives simply because a belt material is available which permits of realizing the many group-drive advantages without being subject to abnormal slip losses or heavy maintenance costs.
General Belt Data
This mill has a total of 48,384 spindles and is one of the most up-to-date in its section. A large proportion of
Survey No. GK-51-GZ Date 1-19-29 MD Page 2
This survey is not to be regarded as a recommendation by A. C. Nielsen Company of the product surveyed. The conclusions refer only to the specific case investigated.

OTHER INDUSTRIAL PRODUCTS

Leather Belting
Rubber Transmission Conveyor and Elevator Belting
Mechanical Rubber Goods
Lace Leather
Round Belting
Belt Cements and Dressings
Leather Pickers
Lugs and other Loom Straps
Woven Textile Lug Straps
Leather Link "V" Belting
Leather Cups
"U" and Flange Packings
Hand Leathers
Leather and Rubber Washers and Discs
Textile Aprons

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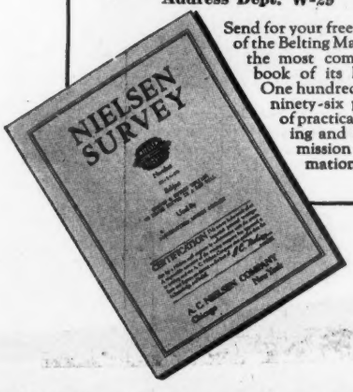


Send for your free copy of the Belting Manual, the most complete book of its kind. One hundred and ninety-six pages of practical belting and transmission information.

"Greater Efficiency of Graton & Knight Belting Makes Group Drives Even More Practical—Survey Shows"

"Every plant engineer is acquainted with the many group drive advantages. Lower installation costs, lower power costs, lower maintenance costs, better power factors. One drawback has been the difficulty in obtaining belting that would enable users to realize fully, the many group drive advantages.

One paragraph in this survey made recently by the A. C. Neilsen Company, engineers, is therefore significant to every man who is responsible for operating efficiency costs. 'There is now a decided tendency toward the use of group instead of individual drives simply because a Belt material (Graton & Knight Belting) is available which permits of realizing the many group drive advantages.'

Actual performance and cost figures that prove the greater efficiency, the longer wear and the money saving capacity of Graton & Knight Belting are contained in this survey and a number of others made in plants in all industries. We shall be glad to send you copies if you will write for them."

Graton & Knight Company
Worcester, Mass.

GRATON AND KNIGHT

Graton & Knight

Standardized

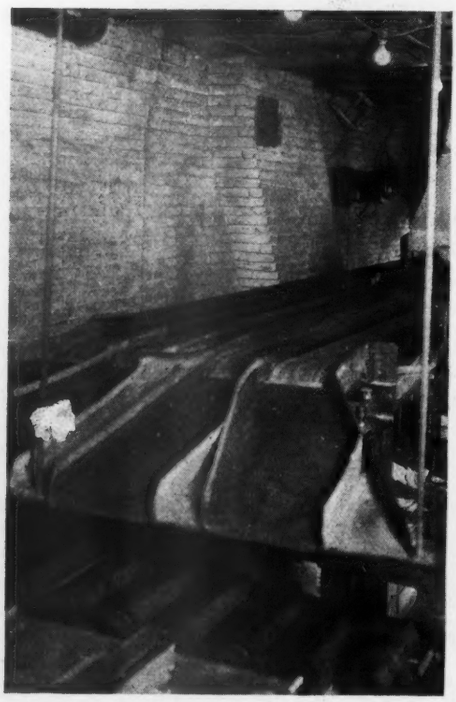
LEATHER BELTING LASTS LONGER

FABR

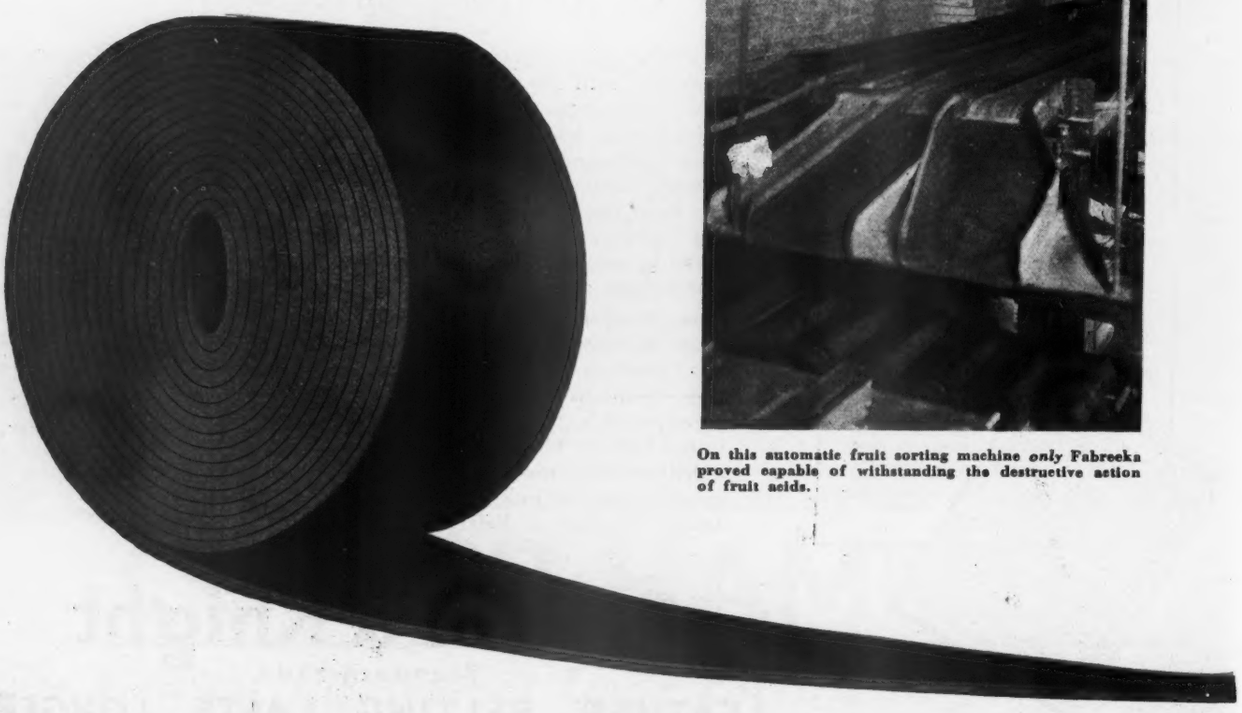
Conveyor Belting

Is sanitary for handling fruit, confectionery or food. Fabreeka is non-porous and can be cleaned with hot or cold water or with steam.

DEHYDRATING PROCESS CO.
FRIENDS BROS.
LEVER BROS.
NATIONAL BISCUIT CO.
CONTINENTAL CAN CO.
WESTERN UNION TELEGRAPH CO.
KIRKMAN & SON
O'DONNELL FISH CO.
WM. CARTER CO.
SAWYER & DAY



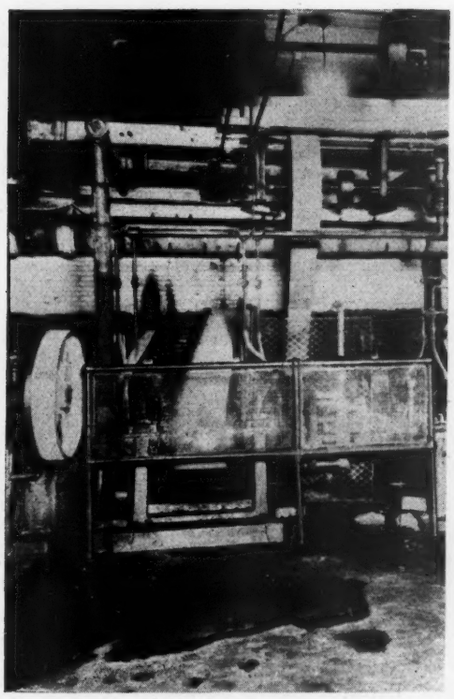
On this automatic fruit sorting machine *only* Fabreeka proved capable of withstanding the destructive action of fruit acids.



EEKA

Transmission Belting

Is uniform, the two ends of a Fabreeka Belt are the same thickness. With proper fasteners the inside of the belt has no "jumpy" places, no thick and thin spots.



A heavy duty Fabreeka Belt on this main drive eliminates vibration and slapping by the smooth steady pull of the uniform inner surface.

INTERNATIONAL HARVESTER CO.
AMERICAN WOOLEN CO.
BIGELOW-HARTFORD CARPET CO.
ENDICOTT-JOHNSON
SEARS, ROEBUCK & CO.
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FABREEKA BELTING COMPANY

20 East St., Boston, Mass.

New York: 461 Eighth Ave.
Chicago: 529 So. Franklin St.

Febreeka Belting Co.
20 East St.
Boston, Mass.

Please send us without charge a Fabreeka Conveyor — Transmission Data Sheet and sample of belt.

Name and Title.....

Company Name.....

Street.....

City and State.....3489

ARMCO
Ingot Iron

Valuable stores of cotton seed meal in this building of the San Diego Oil Products Company are adequately protected by ARMCO Ingot Iron roofing and siding. Mr. E. A. Peacock, the company engineer, had a most satisfactory experience with pure iron amid the tropical rigors of the Philippine Islands. So it was but natural that he should again choose ARMCO Ingot Iron for this important job.

Cotton gin and compress owners can cut their rust bill this way

For 13 years the ARMCO Ingot Iron covering on these buildings of the Union Cotton Oil Company, Birmingham, has protected both the owner's equipment and stores and his investment in plant covering.

Exhaust pipe and ventilators of ARMCO Ingot Iron have given the Monticello Cotton Mills (Monticello, Arkansas) such long, low-cost service that the engineers decided to standardize on pure iron for all sheet metal construction where corrosion threatens.

THE impressive record of ARMCO Ingot Iron in the cotton and allied industries concerns every economy-seeking engineer and plant owner. It points the way to substantial savings.

In roofing and siding, blower ducts, ventilators, machine guards, and other sheet metal construction, this durable iron has outlasted ordinary metals, conserved many dollars for its satisfied owners.

Highly-refined—free from rust-promoting impurities—with the added protection of a heavy galvanized coating, ARMCO Ingot Iron is made to last. Twenty-two years of uncompromising service, under some of the severest conditions, has demonstrated the inherent durability of this "purest of all irons."

Possibly you have a sheet metal problem that merits investigation by an ARMCO Development Engineer. We shall be glad to assist any plant owner who seeks to reduce his rust bill. Just communicate with the nearest office shown below.

THE AMERICAN ROLLING MILL CO.
Executive Offices, Middletown, Ohio
Export: The ARMCO International Corporation
***Cable Address*—ARMCO, Middletown (O)**

DISTRICT OFFICES

Chicago	Detroit	Pittsburgh
Cincinnati	New York	St. Louis
Cleveland	Philadelphia	San Francisco

ARMCO INGOT IRON RESISTS RUST

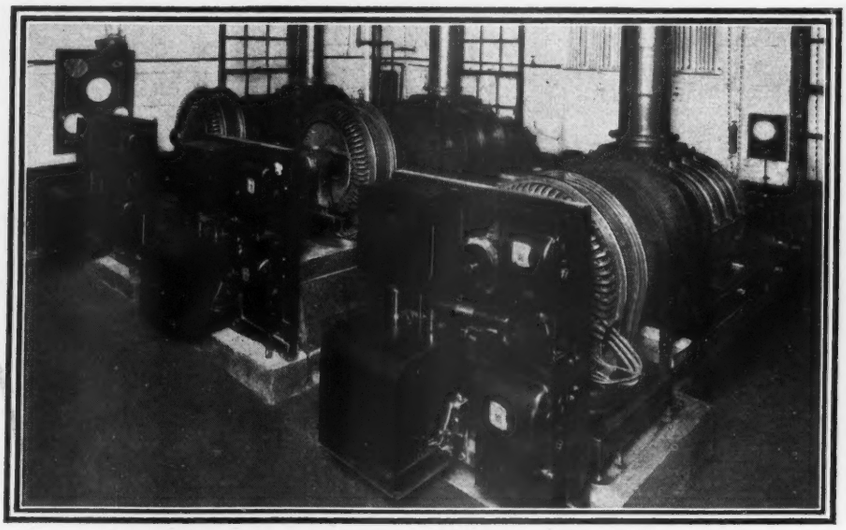
Automatic Control for All Sizes of SYNCHRONOUS MOTORS

SYNCHRONOUS Motors of all sizes . . . small, as well as large . . . are made practical for a very wide range of applications by inexpensive, simple, compact, automatic and semi-automatic E-M Starters. This means that small equipment can be economically driven by small E-M Synchronous Motors.

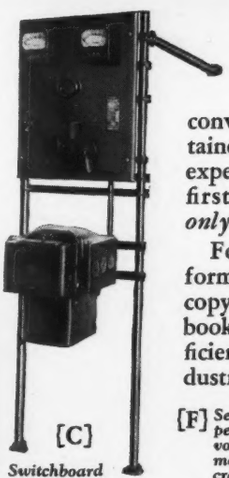
E-M Starters afford automatic control of synchronization. They are fool proof and trouble proof. They provide push-button starting in all but the small, inexpensive sizes. Even with these latter, the attendant need not be skilled, as he performs exactly the same operation as in starting a squirrel-cage induction motor. As a matter of fact, there are many E-M Starters, both automatic and semi-automatic, being operated by men who are not aware they are starting Synchronous Motors . . . do not know the difference between synchronous and induction motors.

E-M semi-automatic starters are compact —as may be seen from the illustrations here. They may be set up near the motor in any convenient location, as shown in (b) and (f), or obtained panel-mounted, as shown in (c). They are inexpensive and their first cost is their *only* cost.

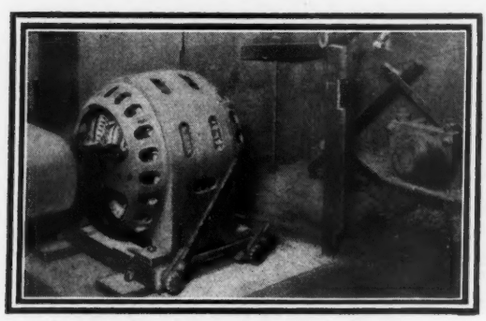
For detailed information, ask for a copy of our 56-page book, "The Most Efficient Drive in Industry."



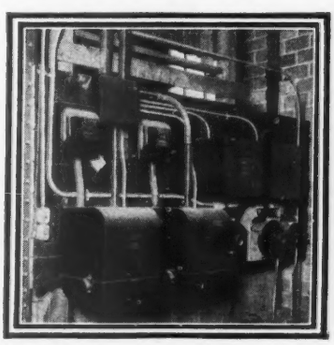
[B] *Two 75 H.P. and one 100 H.P., 300 R.P.M. E-M Synchronous motor-driven blowers at the Consolidated Gas & Electric Co., Baltimore, Md. Note how the E-M semi-automatic controls are installed adjacent to the motors.*



[C] *Switchboard type semi-automatic E-M starter. Synchronization is automatically maintained by the field control mounted on the panel. Full automatic starters with push-button operation are available when desired.*



Cinder screen driven by 60 H.P., 900 R.P.M. bracket type synchronous motor at plant of Cinder Concrete Units Corp., Somerville, Mass. The E-M Control for this motor is shown in photograph directly across the page.



[F] *Semi-automatic, compensator type, reduced voltage E-M Starter for motor at Cinder Concrete Units Corporation shown at left hand side of page.*

Electric Machinery Mfg. Company

Specialists in Apparatus for Power Factor Improvement

1335 Tyler Street, N. E. Minneapolis, Minn.

Sales Offices in Principal Cities

Users of E-M equipment are assured of quick, reliable service by a corps of trained engineers working out of E-M offices in 40 cities. The specialized, quick-moving E-M factory and sales organization is always ready to give you prompt, skilled attention.

EM *Synchronous* MOTORS

THE DEPENDABLE, ECONOMICAL DRIVE OF PROVEN PERFORMANCE

(1017)

Announcing the Shepard Compact Hoist

Consider these features...

1. Sectionalized construction provides a Compact Hoist specially suited to the job... without the cost of special manufacture.
2. Enduring strength is wrought into every detail of the all-steel Shepard Compact Hoist.
3. All moving parts operate in an oil bath, assuring proper lubrication at all times... automatically.
4. Heat treated gears are used in the planetary train.
5. Specially designed motors afford a sure start and a quick stop.
6. Response to controls is instant... positive.

In every detail the Compact Hoist represents the finest that Shepard has produced. It is fortified throughout with the very best of steel... and proportioned to assure the utmost strength per pound of weight.

Safety load block... improved electric brake and limit switch... cooling fins on the load brake... heat treated steel gears... special motor... these are some of the features which Shepard has added to make the new Compact Hoist veritably "a hoist that won't grow old".

Shepard representatives are located in the principal cities from coast to coast. They will be glad to give you complete information.

SHEPARD NILES CRANE & HOIST CORP.
415 Schuyler Ave. Montour Falls, N.Y.
Works: Montour Falls, N.Y., Philadelphia, Pa.

SHEPARD
CRANE & HOIST DIVISION

Member EIMA
ELECTRIC HOIST MANUFACTURERS ASSOCIATION

411 © C. H. E. Co., 1929

Cooper Hewitt illumination in the pattern department of the Bullard Machine Co., Bridgeport, Conn.

How "*Better than Daylight*" Helps Produce Bullard's Famous Precision Machines

BETTER THAN DAYLIGHT

Not a mere claim—but a statement of fact

Cooper Hewitts are "better than daylight" not only because they give constant intensity at any hour but because they yield 90% yellow-green (the best-seeing) rays, and have none of the glare-producing qualities which are hard on the eyes. As a result, every detail becomes sharp and clear as if magnified, vision is more acute and the response of brain and hand is more rapid.

MACHINES that must perform infinitely accurate work—some of them with adjustments to within 1/2000 of an inch! Little wonder that, in manufacturing them, the Bullard Machine Company of Bridgeport, Conn., is most exacting about the illumination under which they are produced.

Workmen must see sharply and clearly every smallest detail of their work. Eye-straining glare from gleaming metals and polished machine surfaces—so easily possible in such a plant—must be eliminated.

So Bullard machines are made under Cooper Hewitt light—the "better than daylight" illumination which is used today in virtually all the leading industrial plants of the country—by Ford, General Motors, Graham Paige, Chrysler, the outstanding metal shops, textile mills, newspapers and similar places where quick, accurate, easy vision is essential.

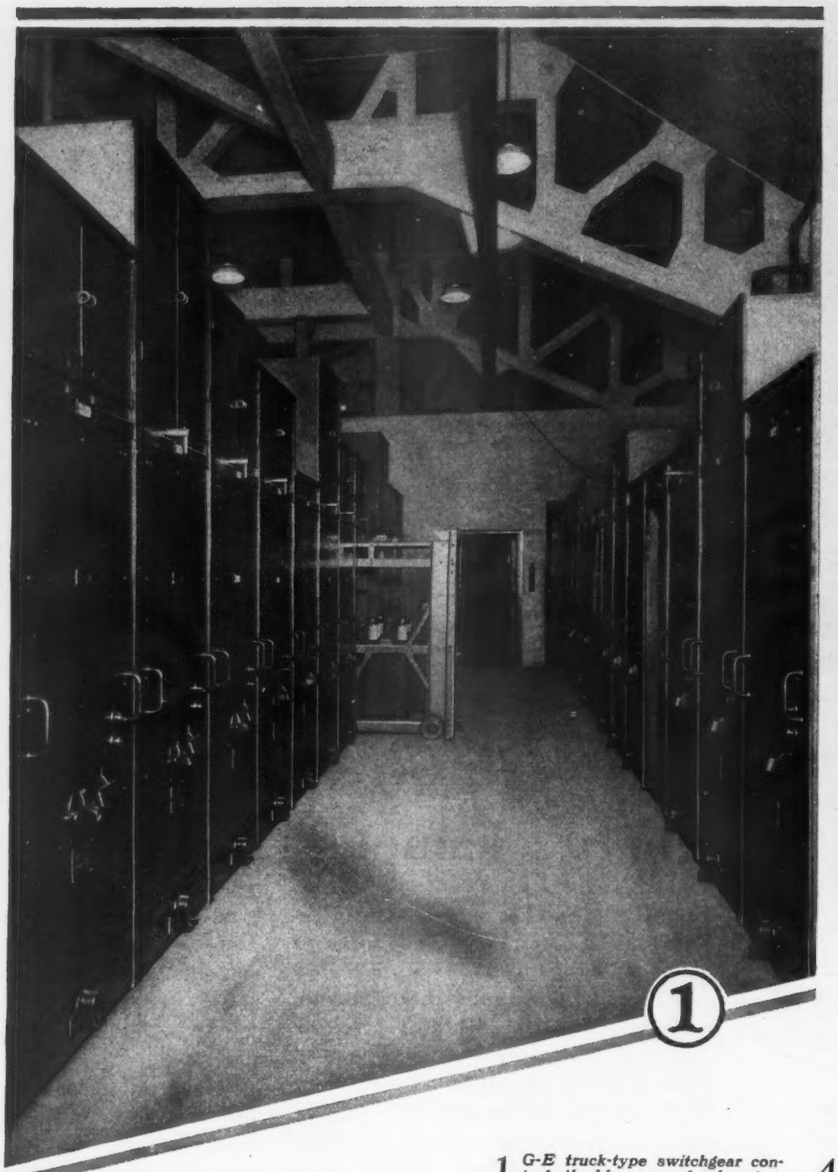
In the photograph above is indicated how well Cooper Hewitt mercury-vapor lamps illuminate the pattern department of the Bullard Machine Company's plant. Accuracy and precision in pattern making, naturally, is of utmost importance. Let us show you, by a trial installation in your own plant, the many advantages of this "better than daylight" illumination.

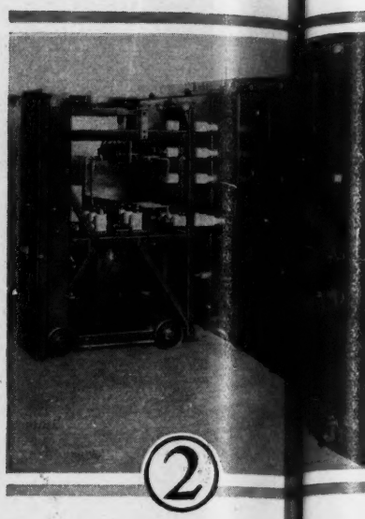
Address: Cooper Hewitt Electric Co., 817 Adams St., Hoboken, N. J.

COOPER HEWITT

A General Electric Organization

Wheel Your Switch-ge





1 *G-E truck-type switchgear controls the blowers and exhausters in the Holland Tunnel*

2 *The switching equipment in the new grain elevator of the A. E. Staley Manufacturing Company*

3 *Truck-type switchboards at Harmon Station on the New York Central Railroad*

4 *Truck-type switchgear in the Bush Terminal Building, New York City, provides safe electrical service*

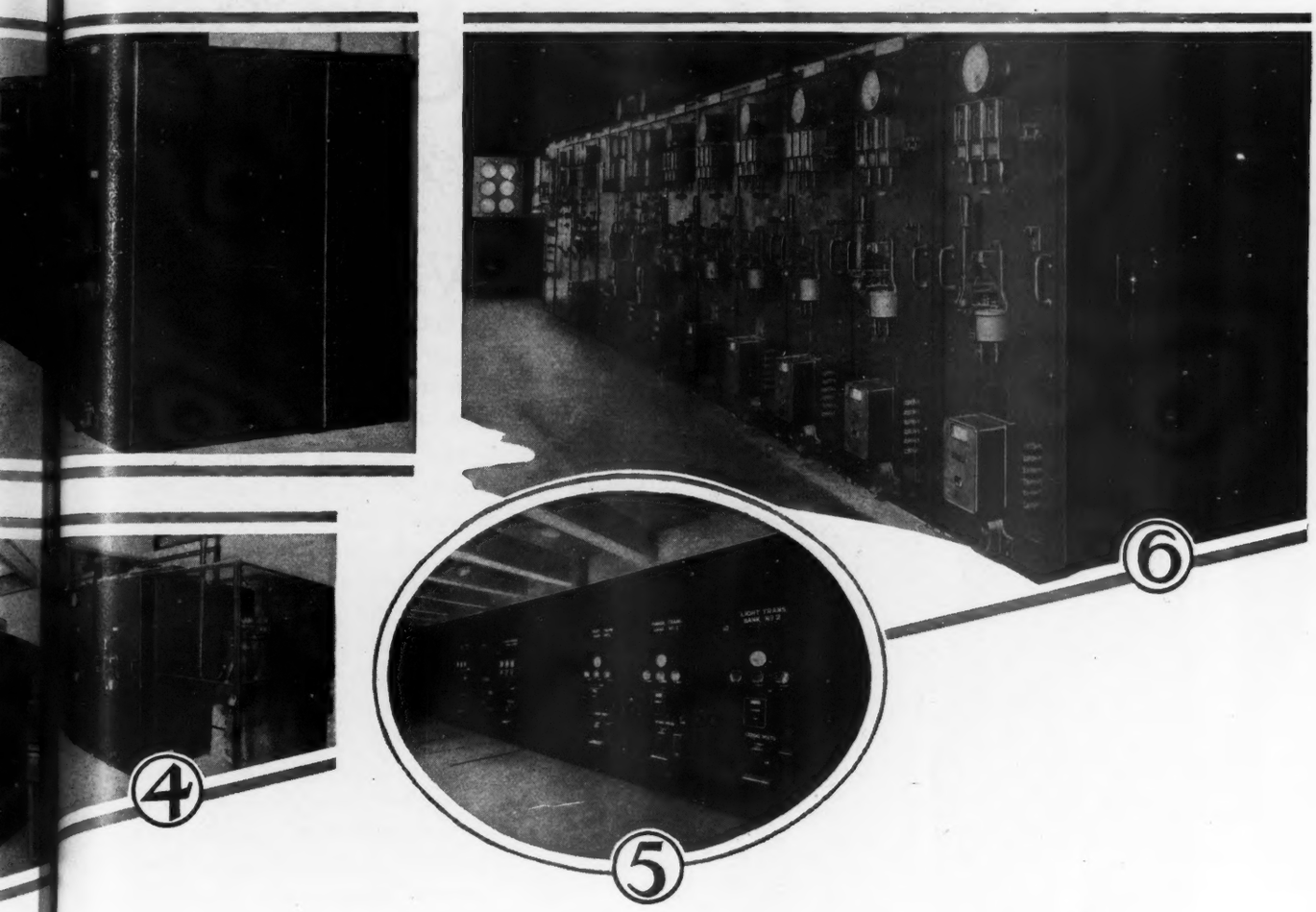
5 *Electrical service in the Fidelity-Philadelphia Trust Company Building is protected by G-E truck-type switchgear*

6 *Truck-type switchgear in the Plainfield Plant of the International Motor Company, maker of Mack trucks*

GENERAL

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

gear Into Place



G-E truck-type switchgear has solved the problem of guarding, measuring, controlling, and distributing power in many industries. If you are considering an investment in switchgear, or the replacement of existing equipment, remember that switchboard units are now manufactured which can be easily and quickly wheeled into place. The advantages afforded by this type of apparatus may be the very ones for which you are looking.

The equipment is totally enclosed, reducing fire hazard; it can be inexpensively and quickly installed, as it is shipped completely assembled; and it affords protection for operators because live parts are totally enclosed. With these switchboards, the period of service interruptions for adjustment and inspection of the apparatus is short, because a truck unit can be withdrawn and replaced by a spare truck—a material operating economy.

461-24

ELECTRIC

SALES OFFICES IN PRINCIPAL CITIES

Wiped Out

with the sweep of a trowel

WHEN Johns-Manville Refractory Cement is used you can count on *extra performance,* on longer life of furnace settings. And that, of course, means less time lost and more profits.

The ability of the famous J-M Three (No. 31, No. 32 and No. 20) to protect fire brick against the most severe conditions is amazing. Spalling, slagging and failure of structure are greatly retarded in furnaces set with J-M Refractories. Each of the three types is suitable for use in general industrial furnaces. For special conditions there are other special J-M Refractories. Behind all Johns-Manville Refractories is 18 years' experience in development work. Here are the famous "J-M Three":—

Johns-Manville No. 31 Refractory Cement—a dry cement to be used in a bond joint, that is, a joint from 1/8 in. to 3/16 in. thick.

Johns-Manville No. 32 Refractory Cement—a dry cement to be used as a dipped or brick-to-brick joint, that is, where a minimum of cement is used between bricks.

Johns-Manville No. 20 Plastic Cement—a plastic cement for either a dipped or bonded joint.

Send us the convenient coupon and receive our booklet about refractory cements.

JM

Johns-Manville
REFRACTORY CEMENTS

JOHNS-MANVILLE CORPORATION
New York Chicago Cleveland San Francisco Toronto
(Branches in all large cities)

Please send me a copy of your booklet, "Johns-Manville Refractory Cements."

*Name*_____

*Company*_____

RC-29-12

*Address*_____

A Testimonial to Silent Operation

THE FACT that so many of the nation's theaters are equipped with Howell Red Band Motors, is convincing evidence of their quiet, efficient operation.

They play the all-important roles of silently driving the giant fans which heat and ventilate the great auditoriums.

Hotels, libraries and other public buildings where silence and reliability are prime factors also are equipped with Red Bands.

A list of public buildings equipped with Howell Motors will be sent to you on request.

Give *Red Bands,* Your Hard Jobs

Howell Electric Motors Company

HOWELL MICHIGAN

SALES *and* SERVICE *in* PRINCIPAL CITIES

THE SEVENTH OF A SERIES OF ADVERTISEMENTS SHOWING THE PART PLAYED IN INDUSTRY BY HOWELL MOTORS

DIXONS INDUSTRIAL PAINTS

Last from Eight to Fifteen Years

When you place an order for "paint" you are really buying *protection*—against corrosion or deterioration of the surfaces to which it is to be applied. And records from many big users show that Dixon's Industrial Paints give *longer and better protection* than can be secured in any other way for the same ultimate expense.

The reason is simple. When used over Dixon's Red Lead Graphite Primer, and applied under favorable circumstances, Dixon's Industrial Paints will give from eight to fifteen years' service. That means a saving of at least one repainting in comparison with ordinary paint used under similar circumstances.

Dixon's Industrial Paints,

with the exception of *Bright* Aluminum and Standard Red Oxide, are composed of pure boiled linseed oil, combined with coloring matter, and the highest grade of flake silica-graphite. Fourteen standard colors. Write for color card No. 75BI.

Dixon's Maintenance Floor Paints

give maximum protection to wood, composition, concrete and cement floors. Suitable for use either indoors or outside. Eight standard colors. Write for color card No. 75BF.

Every time you buy cheap paint you add to your painting costs

This is true because two thirds of the cost of an industrial paint job is labor cost. And when you "save" a few cents a gallon on paint you have the big labor cost of repainting long before it is properly due.

Paint Sales Division

JOSEPH DIXON CRUCIBLE CO.

Jersey City, New Jersey

D X N TRADE MARK

Established 1827

Compare it

with any other starter of equal rating

for

Performance

Upkeep, Safety

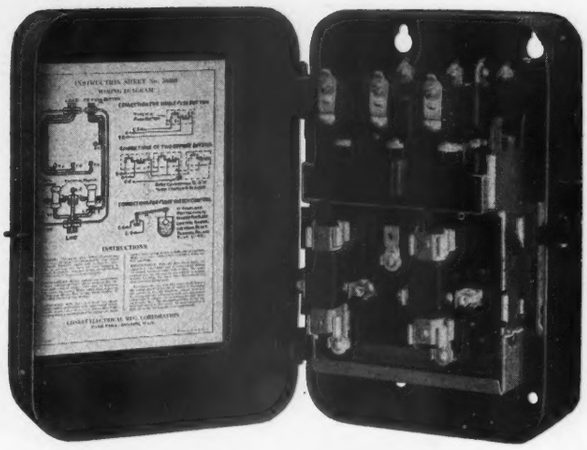
Accessibility

Simplicity, Size

Installation Cost

and

Price



Type A-30 Air Motor Starter

Remember—

Unretouched photograph of arcing accompanying the interruption of the locked rotor current of a 15 H. P. 550 volt squirrel cage induction motor by a contactor type motor starter.

hardly an arc—only a spark

Unretouched photograph of the interruption by the type A-30 under precisely duplicate conditions as that of the old type starter opposite. Hardly an arc—only a spark.

"*Get in touch with Condit*"

CONDIT ELECTRICAL MFG. CORPORATION

Manufacturers of Electrical Protective Devices

BOSTON, MASS.

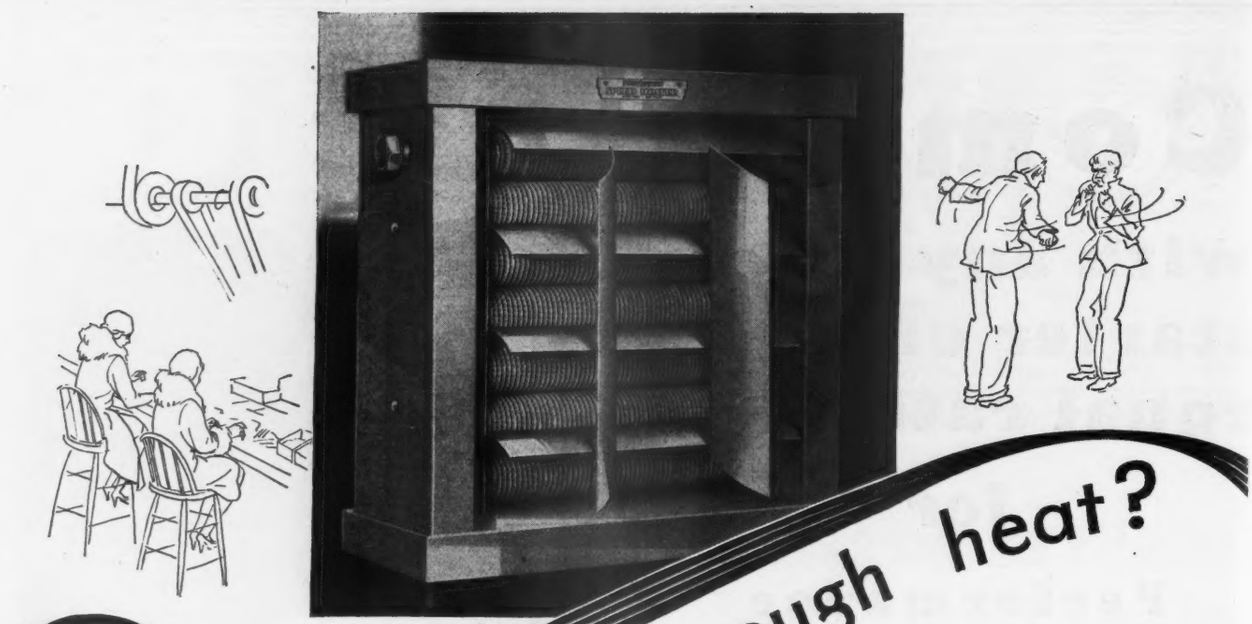
Northern Electric Company
LIMITED

Distributor for the Dominion of Canada

SPECIFICATIONS: 3 pole for across-the-line starting service with squirrel cage induction motors up to 20 H. P., 550 and 440 volts; 15 H. P., 220 volts: 7½ H. P. 110 volts. Approved by Underwriters Laboratories and Associated Factory Mutual Companies

CONDIT

3270



WHAT? Not enough heat?

—with SPEED HEATERS at these prices?

SPEED HEATERS will bring to a cold plant what food brings to a hungry man... smiles! And there is no longer any need to think that to increase plant heating means remodelling.

SPEED HEATERS are hung overhead in cool corners... at open doorways... in drafty workshops... in just those particular departments where most complaints come from.

Their installation is no job at all. But the effect is magical. After shutdown, for instance, SPEED HEATERS provide a comfortable working temperature in a few minutes after steam is turned on. Noiseless, troubleless... and dressed up like nobody's business!

At least, get details and prices! See the Coupon? THANKS!

THE PRICE IS 'WAY DOWN

COUPON

B. F. STURTEVANT CO.
Hyde Park, Boston, Mass.

Kindly send me a copy of the SPEED HEATER DATA BOOK.

Name .....

Street Address .....

City ..... *State* .....

B. F. STURTEVANT COMPANY

Plants and Offices at: Berkeley, Cal. ◂ Camden, N. J. ◂ Framingham, Mass. Galt, Ontario ◂ Hyde Park, Mass. ◂ Sturtevant, Wis.

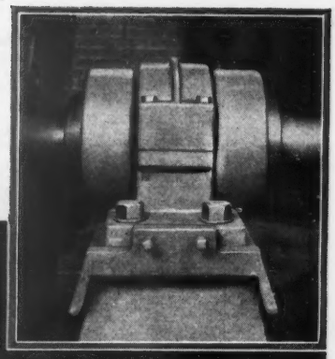
Branch Offices at: Atlanta; Boston; Buffalo; Camden; Charlotte; Chicago; Cincinnati; Cleveland; Dallas; Denver; Detroit; Hartford; Indianapolis; Kansas City; Los Angeles; Milwaukee; Minneapolis; Newark; New York; Omaha; Pittsburgh; Portland; Rochester; St. Louis; San Francisco; Seattle; Washington, D.C. *Canadian Offices at:* Toronto; Montreal and Galt. ◂ *Canadian Representative:* Kipp Kelly, Ltd., Winnipeg

Also Agents in Principal Foreign Countries

Sturtevant
(REG. U. S. PAT. OFF.)

SPEED HEATERS
"More Heat Less Steam"

Dividends!



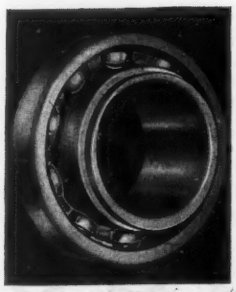
paid by GIANT FAFNIR PILLOW BLOCKS to the E. & G. Brooke Iron Co. . .

Brooke's whole production schedule rests on these two huge Fafnir Pillow Blocks supporting the shaft of the 100-inch fan. And the plant has run 24 hours a day, since the Fafnirs were put in. Before that, shutdowns from plain bearing breakdowns were "all in the day's work."

The dividends paid by Fafnirs offset their cost in about a year . . . now they have a towering balance to their credit. They reduced power consumption . . . increased *and stabilized* production . . . ended maintenance labor on the fan . . . and save gallons of oil every month. Fafnirs are greased once or twice a year, and beyond that they take care of themselves. Ashes, dust, and grit are kept out. Lubricant is kept in.

Wherever production schedules depend on bearings, fortify the crucial points with Fafnirs. You will find—as Brooke has found—that Fafnirs "do all they're guaranteed to do—and more!"

THE FAFNIR BEARING CO., NEW BRITAIN, CONN.
Newark - Chicago - Cleveland - Detroit - Philadelphia - Milwaukee



FAFNIR
BALL BEARINGS

THE MOST COMPLETE LINE OF BALL BEARINGS IN AMERICA

TIREX—the cable with greater resistance to abrasion

TIREX is the smooth, clean cable at the right

A story, far more descriptive than words, is told by the photograph above which shows two types of charging cable that have been in service for the same length of time.

Where service conditions require cable that is almost wearproof, TIREX is recommended because it is protected by the toughest outer rubber sheath made.

TIREX charging cable is extremely flexible, will not kink, fray, break or crack and is not appreciably damaged by contact with acids or water. If you have not used TIREX cables you owe it to yourself to make a test on your own property under conditions you shall determine.

Before purchasing charging cable send for complete information and a sample of TIREX so that you may see why it is the economical cable to buy.

SIMPLEX WIRE & CABLE Co

MANUFACTURERS

201 DEVONSHIRE ST., BOSTON

BRANCH SALES OFFICES

CHICAGO, 564 W. Monroe St. SAN FRANCISCO, 390 Fourth St.
NEW YORK, 1328 Broadway CLEVELAND, 2019 Union Trust Bldg
JACKSONVILLE, 1010 Barnett Nat'l Bank Bldg.

TIREX CABLES

The *Costliest* Motor Trouble is CARBONIZATION of Motor Windings

REPLACEMENT cost of a bearing, a belt pulley or even a damaged shaft is very low. But if it is necessary to re-wind an electrical motor, the cost is approximately 60% of the price of a new motor.

The interruption to service often proves more expensive than the actual cost of re-winding.

Therefore, by the elimination of the principal cause of carbonization, these expenses are prevented.

What is the underlying fault which permits carbonization of windings in motors?

The answer is in the fact that motor insulations usually consist of materials that will carbonize under the temperatures which frequently occur in motor operation and thus threaten the destruction of the windings. Instead of remaining an insulation, the carbonizing material becomes a conductor.

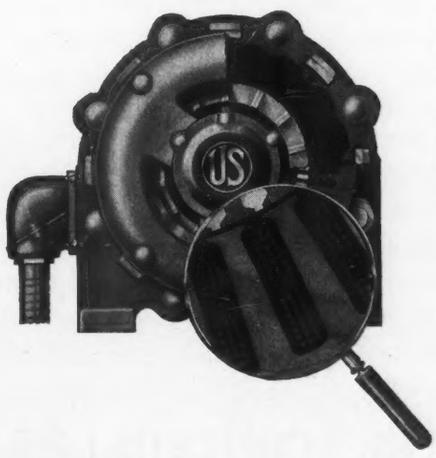
But in U. S. MOTORS the windings are protected by Asbestos, the only known fibre that is absolutely incombustible.

Producing Asbestos Insulation

When Asbestos insulation was developed for U. S. MOTORS there was no manufacturing plant in the country which offered facilities for processing Asbestos fibre suitable for U. S. MOTOR application. It was necessary for the U. S. organization to devise means for producing this material. So in the U. S. plant the pure asbestos is first treated to render it non-hygroscopic, —then processed and formed for use in the slots, coils and windings of the stators.

U. S. MOTORS are impregnated with Asbestosite, a heat resisting compound, the base of which is asbestos. In the U. S. impregnation process each wire is isolated with a coating of this non-carbonizing insulation. This is accomplished by inductively vibrating the coils of the windings while immersed,—a patented process controlled exclusively by U. S. MOTORS.

¼ H. P. to 125 H. P. RATINGS
Horizontal and vertical motors of many types for modern industry.



The interesting details of the processing of U. S. MOTORS with asbestos insulation is presented in the pamphlet, "Asbestos Protection." A copy will be sent upon request to any distributing office listed below.

Perhaps you would also like to have a copy of the bulletin, "U.S. AUTOSTART MOTORS."

U. S. MOTORS

ASBESTOS PROTECTED

U. S. ELECTRICAL MFG. CO.

DISTRIBUTING OFFICES

ATLANTA, GA.	HONOLULU, T. H.	PITTSBURGH, PA.
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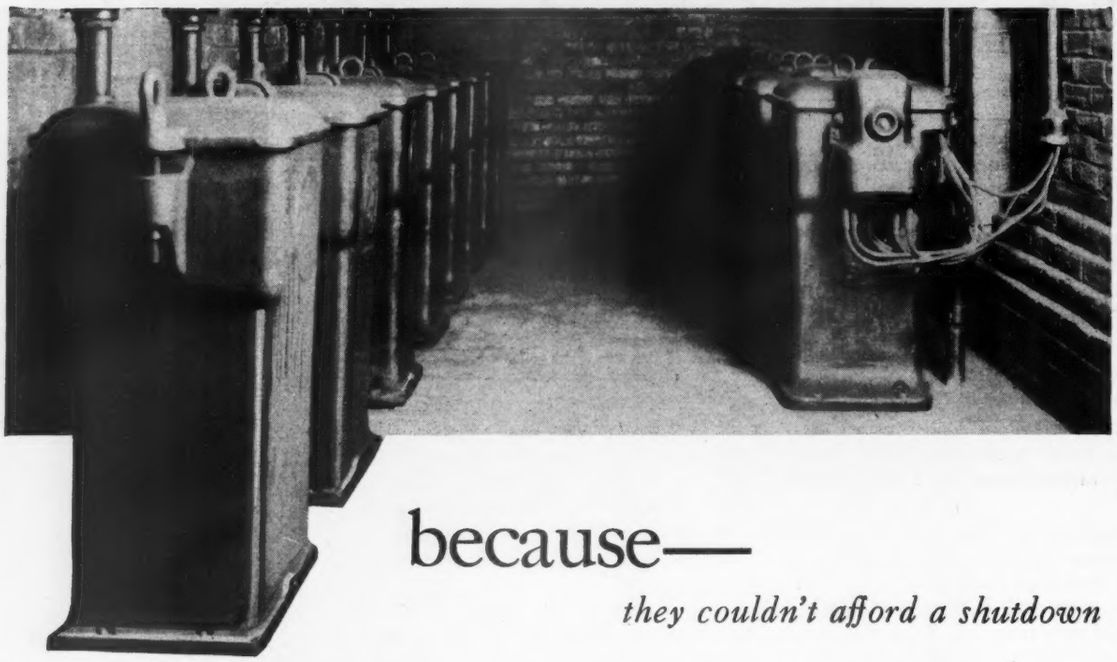
208 San Francisco St.	16 N. 2nd Ave.	1260 Hamilton Ave.

The management of this plant selected EC&M Equipment



because—

they couldn't afford a shutdown

Realizing the importance of continuous production, the management of this plant selected EC&M Automatic Compensators because they wanted trouble-free operation.

With only an occasional inspection, once every year being sufficient in most cases, EC&M Motor Starters guarantee that uninterrupted service which is so vital to the maximum output of a plant.

Desiring to start the motors from push-button control stations located at a distance from the motors, the management knew that EC&M equipment would always start the motors correctly and also protect the motors at all times against any abnormal conditions.

EC&M Motor Starters also make a neat installation job. This fact appealed to their pride in the appearance of the plant.

Besides these features, EC&M Oil-Immersed Motor Starters are flame-proof, corrosion-proof, and weather-proof. Write to our nearest branch office for bulletins 1042-F and 1047 describing EC&M Low and High Voltage Automatic Compensators.

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

NEW YORK-50 CHURCH ST.
CHICAGO-CONWAY BLDG.
DETROIT-DIME BANK BLDG.
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DENVER-KITTREDGE BLDG.
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HOUSTON-1006 WASHINGTON AVE.
TORONTO-REFORD BLDG.
PHILADELPHIA-WITHERSPOON BLDG.
PITTSBURGH-OLIVER BLDG.
SAN FRANCISCO-CALL BUILDING
MONTREAL-CASTLE BLDG.
TULSA-217 E. ARCHER ST.
SEATTLE-ALASKA BLDG.

REDUCE
GLARE
that kills production

Glare-blinded workers, obviously, cannot do as *good* work, or do as *much* work, as workers who can use their eyes effectively because eye-strain is eliminated.

Industrial buildings all over the country use Factrolite Glass to speed production. It requires no additional equipment to install it. Factrolite reduces the glare near the windows and increases illumination away from them because it breaks up and scatters the rays of light. 900 minute prisms in every square inch of Factrolite diffuse the light and minimize harmful, waste-producing glare.

Samples of Factrolite (Wire or Plain) gladly sent upon request.

MISSISSIPPI GLASS COMPANY

220 FIFTH AVE. NEW YORK · CHICAGO · ST. LOUIS

FACTROLITE

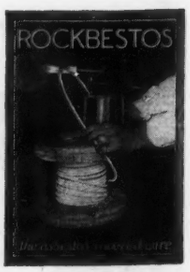
HEAT!

A large rail mill with four Crocker-Wheeler Mill type motors, all safeguarded with ROCKBESTOS

Shutdowns are expensive!

Eliminate those caused through failure of electrical insulation by using ROCKBESTOS, the asbestos insulated wire that is unaffected by high temperatures and all the other destructive conditions met with around equipment such as in the rail mill shown here.

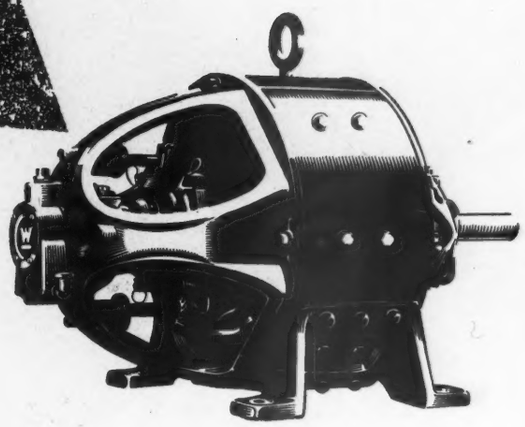
The Crocker-Wheeler Electric Manufacturing Company have long recognized the superior qualities of ROCKBESTOS insulation and safeguard their equipment and assure its continuous operation by using it.



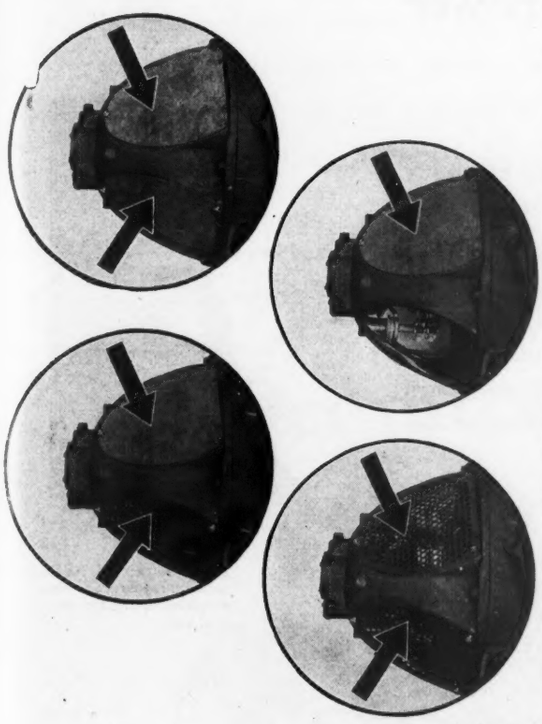
ROCKBESTOS PRODUCTS
CORPORATION
NEW HAVEN, CONN.

5942 Grand Central Term. Bldg., New York
903 Clark Bldg., Pittsburgh, Pa.
716 Madison Term. Bldg., Chicago
On the Pacific Coast—Anaconda Wire & Cable Co.

Follow this Series and learn why more SK Motors are in Industry today than any other D.C. General Purpose Motor.



Full Protection
against the Hazards of Service



DRIPPING water, dust, heat, flying chips, falling objects, mean nothing to the Westinghouse SK motor. It can be protected against every service hazard.

The bearing brackets of type SK motors accommodate cover plates, so that the standard open motor can be readily converted to one which is drip-proof, semi-enclosed, totally enclosed, splash-proof, self-ventilated, or one which is protected by means of any combination of enclosing covers. These plates are flat and may be provided with gaskets, so that an absolutely tight fit is made. Hinged covers meet the requirements of various safety codes. Thus, in one motor design, the safety and protection of many special motors are made possible.

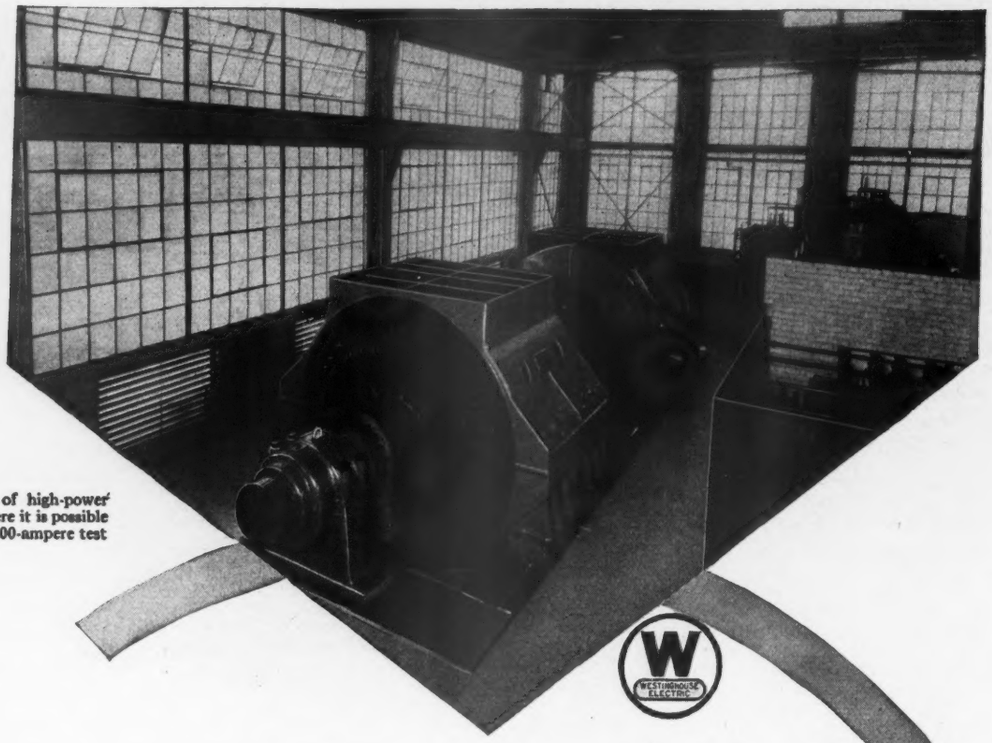
Type SK Motors are designed to give many years of dependable service in constant and adjustable speed applications. Available in sizes from ½ to 250 horsepower. For further details, consult our nearest office.

Numerous well-equipped and efficiently-manned Service Shops throughout the country assure prompt Service to the purchasers of Westinghouse products.

WESTINGHOUSE ELECTRIC & MFG. COMPANY
EAST PITTSBURGH PENNSYLVANIA
SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES

Westinghouse

T 30846



Interior view of high-power laboratory where it is possible to obtain 150,000-ampere test currents.

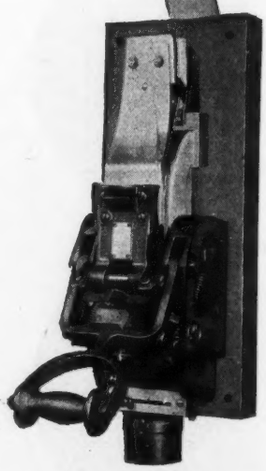
We pass on to you--

the achievements of our high-power laboratory

THE high-power laboratory maintained by Westinghouse has made it possible for electrical development on carbon breakers to keep pace with the ever-changing demands of modern industry.

With the facilities of this laboratory, Westinghouse engineers can establish, as a matter of routine test, electrical currents in excess of 150,000 amperes with which to prove CL breakers for modern industrial plants. This equipment has been responsible for the discard of many traditional design features and has given industry the scientifically designed CL breaker that is establishing new records for trouble-free performance.

Write the Westinghouse office in your locality for circular 1705 which describes the many features of this breaker.

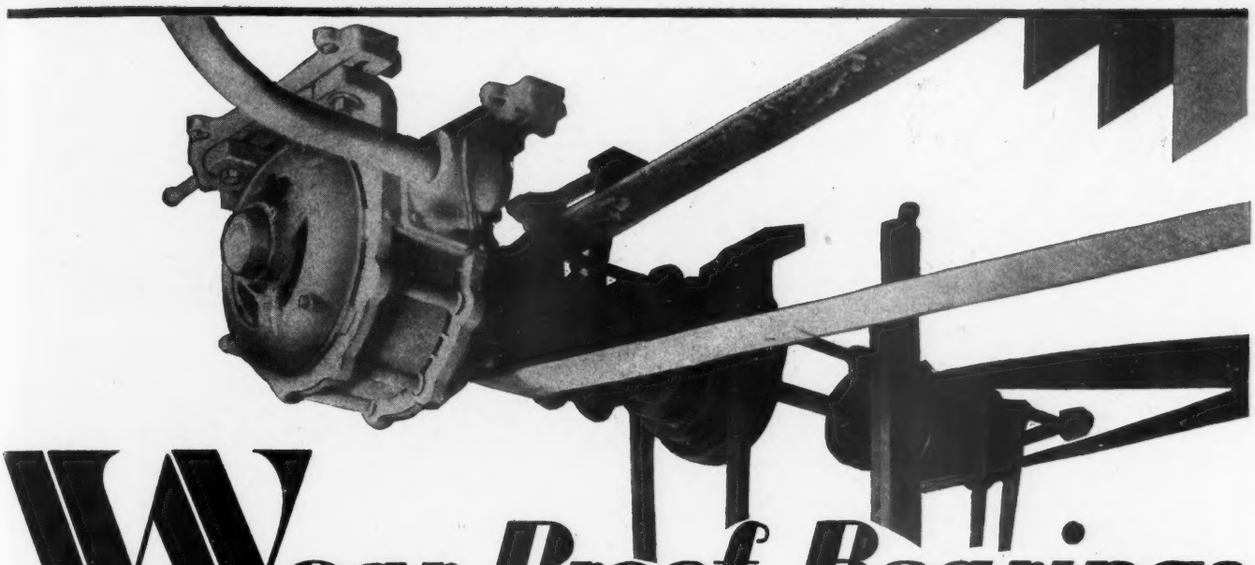


A 4000-ampere CL breaker with its modern one-piece, accessible frame for industrial use.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
EAST PITTSBURGH PENNSYLVANIA
SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES

Westinghouse

T 30898



Wear Proof Bearings in Dust Proof Housings

THE fine, highly absorbent dust of the woodworking shop will not collect and become an oil-soaked mass about the bearing housings of this U. S. Electric Motor — for the grease-lubricated New Departure Ball Bearings used are not only sealed against the entrance of dirt but also against the escape of lubricant.

New Departure-equipped, grease-lubricated ball bearing motors are clean and easy to care for — are free from wear and repair — need greasing not more than once a year and are as dependable as they are economical.

The New Departure Manufacturing Company, General Offices and Main Works, Bristol, Connecticut; Detroit, Chicago and San Francisco.

New Departure Ball Bearings

Check them all off with A.D.T. Protection!

An A. D. T. Central Station where fire alarm, watchman and sprinkler signals are constantly supervised.

SUBJECTING your plant to these hazards is like using obsolete machinery — they both can interfere seriously with production operations. Fire, theft, sprinkler failure watchman failure — check them all off with A. D. T.

A. D. T. Protection Systems include Manual and Automatic Fire Alarm, Watchman's Supervisory, and Sprinkler Supervisory Systems. May be operated locally or through one of the A. D. T. Central Stations located in principal cities.

Protect your plant the modern way — install A. D. T. Complete catalog with engineering data now available.

Controlled Companies of

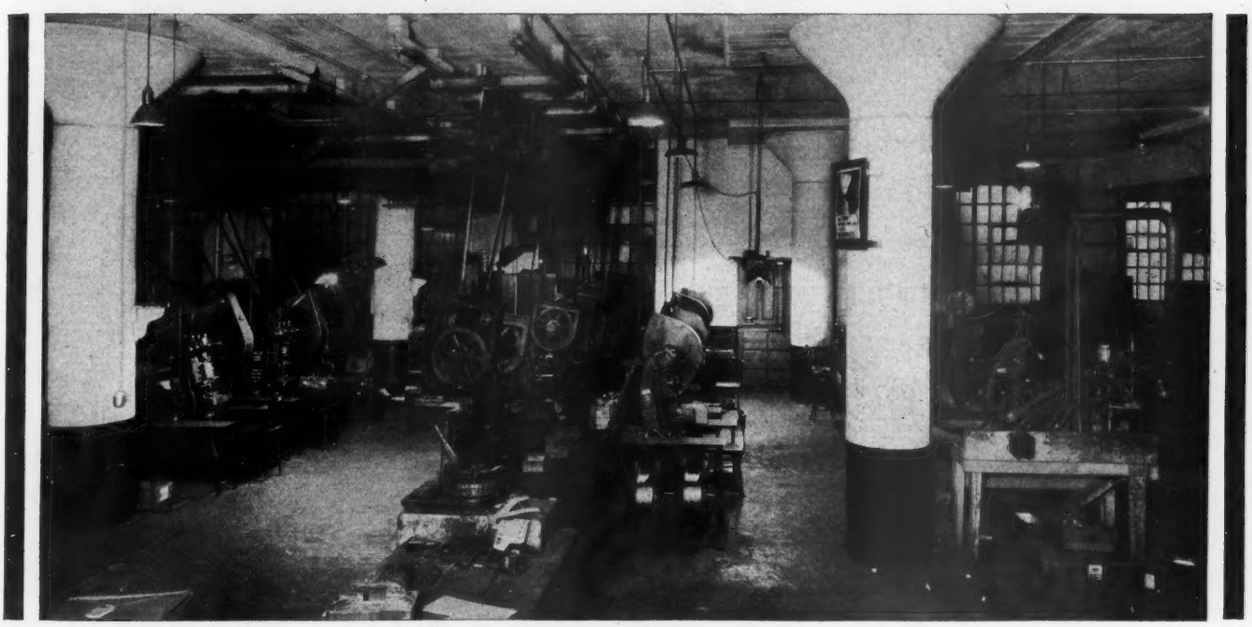
American District Telegraph Company

155 Sixth Avenue, New York, N. Y.

A.D.T. SYSTEM

◆◆ BEHIND THE PYRAMIDS—12 ◆◆

Making BRUSHES exactly to your specifications



Machines for attaching shunts. Plating room in background

MANY National Pyramid Brushes are supplied with shunts, and where necessary are copper plated at the point of attachment to insure a low resistance contact between brush and shunt.

This work is done entirely in our own factories. After the brushes have been sawed and ground to exact size additional special machine operations are performed preparatory to attaching the shunts. Our styles of shunts are standard and meet all requirements of the electrical industry.

The distinguishing visible feature of each shunt is the Silver Strand Cable. This is one of our registered trade-marks, just as much an identification of National Pyramid Brushes as are the letters NCC and the three pyramids. As you pass through power plants, factories, mines and industries the country over, look at the electrical machines. It will not be necessary for you to ask what brushes are being used. The Silver Strand Cable is easily discernible, regardless of how much of the brush itself may be concealed by the brush holder.

The final operation before shipment is a rigid test and inspection. Tests are made for connection resistance, between shunt and brush. Size, angles of bevels, length of shunt and any other special items on the original order, are all checked and verified. Brushes are then carefully wrapped and packed for shipment.

This ends the manufacturing history of National Pyramid Brushes. Over 65 days have been consumed. At least 36 major operations have been performed. Innumerable minor processes have been applied. Scientific tests and controls have been applied constantly. Short cuts have been avoided. And thus the performance of National Pyramid Brushes is safeguarded and the uniformity of grade assured.

An interesting moving picture film illustrating in detail the processes used in the manufacture of carbon brushes will gladly be shown on request to any organization of engineers or students.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide UCC *and Carbon Corporation*

Carbon Sales Division — SILVER STRAND CABLE TRADE MARK REGISTERED — Cleveland, Ohio

Branch Offices and Factories

Jersey City Pittsburgh Chicago Birmingham San Francisco

STRIPS OF HEAT

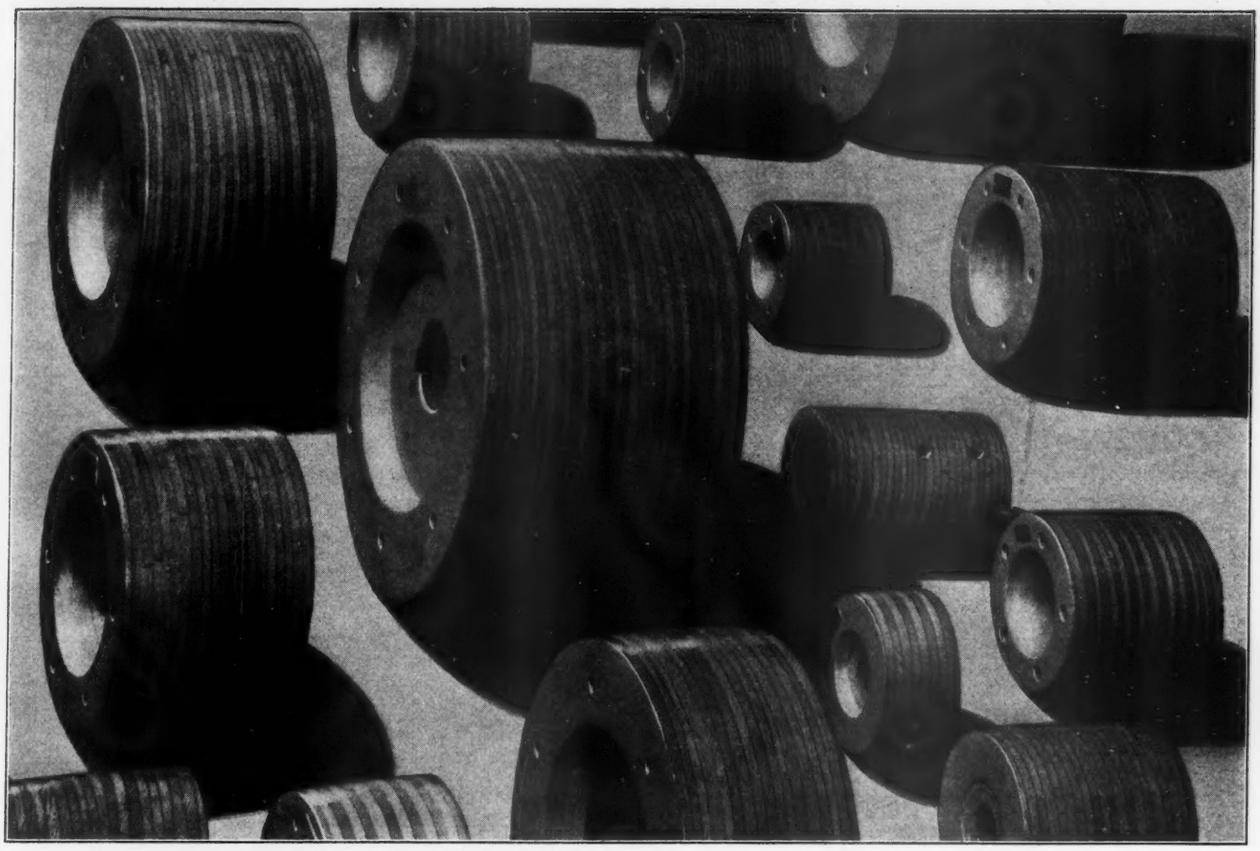
Strips of Heat (G-E electric strip heaters) provide clean, safe, economical, and convenient heat—permitting uniform distribution of heat and accurate automatic control. ¶Use these handy units on your process machines, drying equipment, warming tables, compound tanks, glue tables, oil lines, water baths, valve and pump houses, etc. ¶You won't find better strip heaters, anywhere, than these, made by General Electric—nor any more reasonably priced. Call up or write your nearest G-E office for complete information, prices, and delivery.

570-98

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES



A complete line of superior MOTOR PULLEYS

Here are motor pulleys that are worthy of the AMERICAN Name.

Pulleys that will save you power because AMERICAN Sprucolite motor pulleys have the highest coefficient of friction and weigh but a fraction as much as ordinary paper or cast iron pulleys.

Pulleys that will save you trouble because they are scientifically made to stand up under the most severe conditions, to withstand shock loads and to run true, preserving the crown and edges and protecting the belt.

Pulleys that save space because their better grip permits closer centers.

Pulleys that will save you money because they cost no more than ordinary pulleys, give better service and last longer.

Pulleys that will save you time because of their nation-wide availability through a large number of dealers served by the American Pulley Company warehouses throughout the country.

Now you can standardize on AMERICAN Sprucolite Pulleys for your motors and machines, just as you have always specified AMERICAN Pressed Steel Pulleys for your group and line-shaft drives — and experience the same certainty of lasting satisfaction.

Write for descriptive literature, or ask any dealer about them. You will find it well worth while.

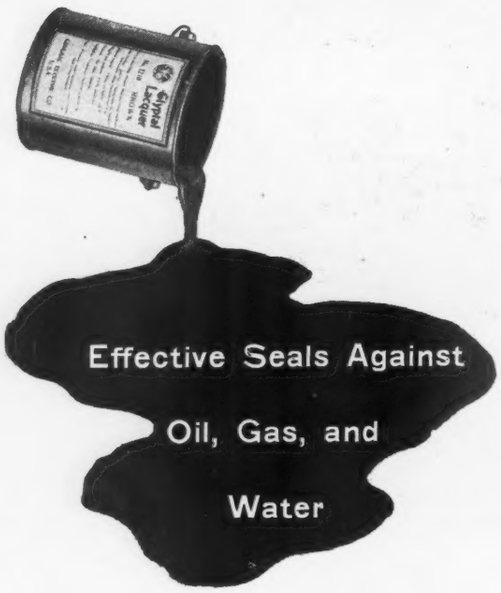
Over 7 Million "American" Pressed Steel Shafting Pulleys and Hangers have been put to work in leading plants throughout the country. Light, strong, durable power transmission units, they are regarded as the standards of quality wherever shafting pulleys and hangers are used.

AMERICAN STEEL SPLIT PULLEYS
PATENTED
REG. U. S. PATENT OFFICE

THE AMERICAN PULLEY CO. 4200 Wissahickon Ave. Philadelphia, Pa. *PRESSED STEEL:* SHAFTING PULLEYS, HANGERS, HAND TRUCKS, MISCELLANEOUS STAMPINGS, *SPRUCOLITE* (Compressed Spruce), MOTOR PULLEYS, MACHINE PULLEYS

AMERICAN SPRUCOLITE PULLEYS

Now is the time to learn about G-E Glyptal lacquers



GENERAL ELECTRIC No. 1201 red GLYPTAL lacquer, the improved G-E No. 880 red protective paint, is especially recommended to stop oil, gas, and water leaks. It is unsurpassed as a sealing agent for tank seams, pipe lines, motor housings, gas mains, and similar applications. No. 1201 provides effective, lasting protection.

Essentially, all G-E GLYPTAL lacquers have the same distinctive qualities. Besides preventing rust, they resist alkalies, weak acids, salt spray, mineral oils, gasoline, and kerosene; they have high dielectric strength; and they withstand extremely high temperatures without discoloration. Moreover, they adhere to all surfaces, including galvanized iron and aluminum, with an unexcelled tenacity.

G-E GLYPTAL lacquers eliminate priming and sizing operations in the finishing of metal surfaces. G-E No. 1451 filler, recommended for use with GLYPTAL lacquers, possesses priming characteristics. The lacquers themselves function as both primer and sizer.

G-E GLYPTAL lacquers, recently invented by the G-E research laboratories, are now available in five colors: red, blue, green, brown, and aluminum—other colors to follow. Let the G-E Merchandise Distributor nearest you explain more about G-E GLYPTAL lacquers or, if you prefer, fill in and mail the coupon.

WRITE FOR *folder*

Merchandise Department,
General Electric Company,
Bridgeport, Conn.
Gentlemen:

I wish to make my own experiments. Please send more detailed information about these new protective finishes.

_____

_____

Section I-4812 _____

800-529

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GLYPTAL LACQUERS

REG. U.S. PAT. OFF.

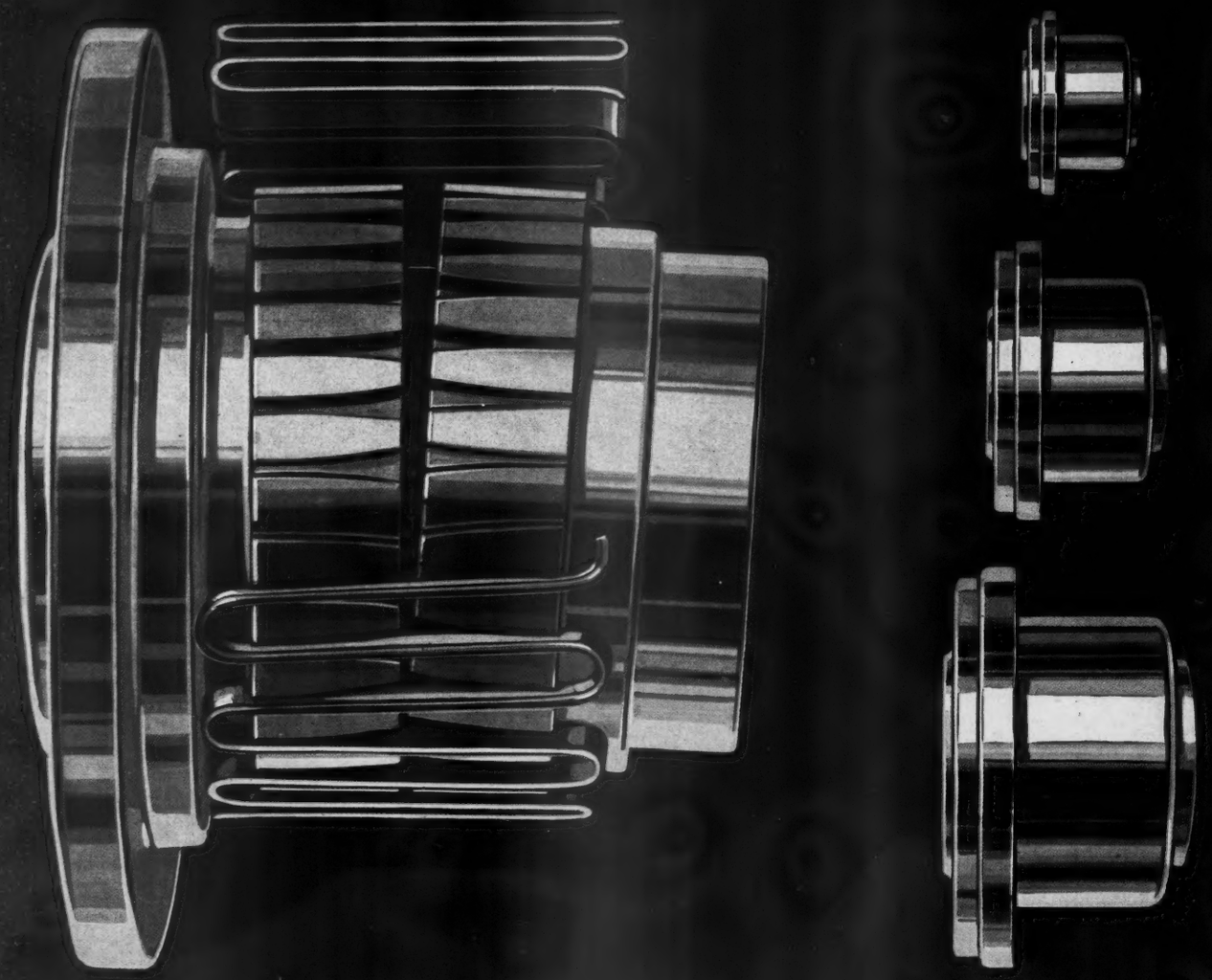
The Heaviest of Industry's Requirements are Masterfully Handled by Falk Heavy Units

To satisfactorily cope with the most severe conditions in heavy industries, Falk Mill Drives and other Special Units reflect quality throughout their entire construction ... While every part is large and powerful, yet each one is precision-built... And wherever these units are in service their performance bears out this quality construction . . . Falk Heavy Units are the acme of engineering skill—they are simple and compact, correctly proportioned in design to carry gigantic loads regardless of service . . . These units are free from vibration and noise, and are outstanding for their high mechanical efficiency . . . They are unusually dependable in operation, durable in build, resulting in low cost of operation . . . Falk Herringbone Gears which assure the carrying of capacity loads most efficiently are used.

Why Falk Heavy Units Are Mechanically Efficient

Every operation in the manufacture of Falk Herringbone Gears, which are a part of Falk Heavy Units, is under Falk control . . . The blanks are cast in the Falk foundry and are cut by a patented process which is exclusive with Falk . . . Every step of production is careful, painstaking and precisely accurate . . . Falk Herringbone Gears are available in both the continuous and staggered tooth types, in diameters from one inch to sixteen feet, in any face width from one inch to six feet, with any pitch from 25 D. P. to ¾ D. P. . . . They are practical for speeds up to 12,000 feet per minute and are from 98% to 99% efficient under continuous full load service . . . Falk Herringbone Gears, Mill Drives and Special Units are custom-built to meet the exacting conditions of the service to which they are put.

FALK
HEAVY UNITS



Falk Flexible Couplings are Positive in Action

. . . Effectively Absorb Shock and Vibration!

In the distribution of power, the function of the Flexible Coupling is paramount . . . It must allow for both angular and parallel misalignment which commonly arise in operation . . . It must absorb shocks . . . It must be dependable . . . It must be all-metal, amply lubricated . . . It must be both torsionly and laterally resilient . . . The Falk Flexible Coupling meets all of these requirements with a margin to spare . . . It provides free end float at all loads . . . It embodies a patented principle that makes for exceptional resiliency with ample strength and ease of installation . . . Falk Flexible Couplings are standardized from 1/5 H. P. to 20,000 H. P. at 100 R. P. M . . . Send for our Coupling Bulletin No. 180.

THE FALK CORPORATION—Milwaukee

NEW YORK	WILKES-BARRE	CLEVELAND	CHICAGO	PORTLAND	DENVER
ALBANY	PITTSBURGH	DETROIT	ST. LOUIS	SAN FRANCISCO	HOUSTON
ROCHESTER	AKRON	KALAMAZOO	MINNEAPOLIS	LOS ANGELES	BIRMINGHAM

Canada: The William Kennedy & Sons, Ltd., Owen Sound, Ontario,
Exclusive Sales Representatives and Licensed Manufacturers under Falk Patents.

Branches: HALIFAX MONTREAL TORONTO COBALT WINNIPEG VANCOUVER

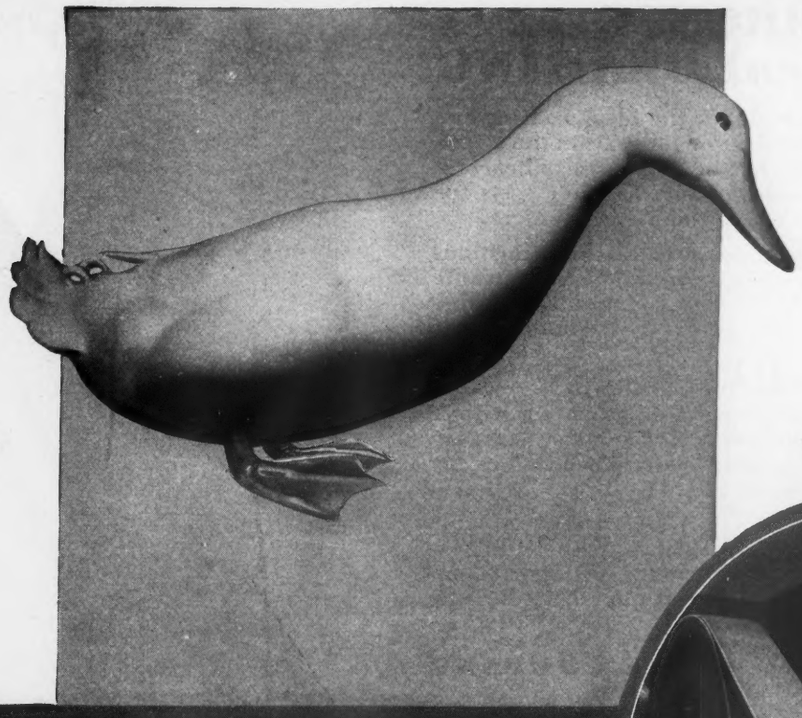
What Falk Flexible Couplings Do!

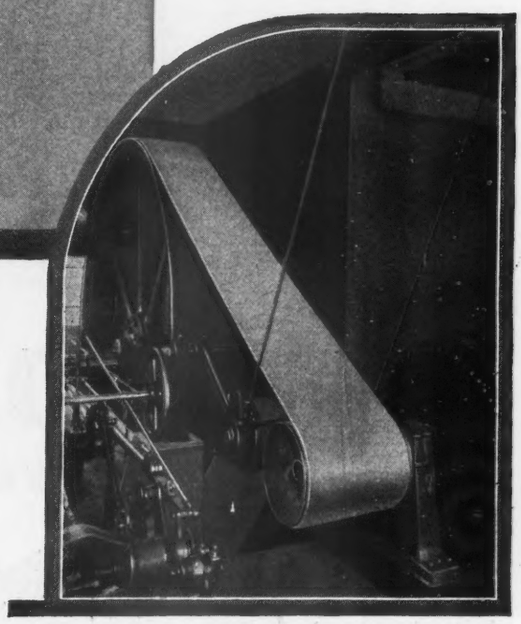
Allow both lateral and torsional elasticity . . . Are easily connected and disconnected . . . Are all-steel . . . Provide widest distribution of pressure . . . Allow most correct lubrication . . . Float freely under load . . . Insure greatest resistance to overloads . . . Absorb shock and vibration . . . Accommodate parallel and angular misalignment. . . . Can be lined up quickly without special tools . . . Cannot rust — springs are packed in grease . . . Have no unreliable elements, which lead to breakdowns . . . Operate equally well in both directions; either end can be the driver.

Other Falk Products—Gears, Speed Reducers, Oil Engines and Steel Castings

FALK

FLEXIBLE COUPLINGS





Everybody knows DUXBAK Belting

FOR MANY YEARS the famous SCHIEREN duck has distinguished DUXBAK BELTING—a brand of leather belting known all over the world for its long life and unusual pliability. Since 1868 the name SCHIEREN has been a factor in leather belting. DUXBAK has never been just a leather belt. It has always been a superior leather belt—tanned in the Schieren Tanneries to meet the grueling service we expect it to render and built according to highest standards of belt craftsmanship.

The DUXBAK Belt shown served 14 years under a severe overload on this very difficult drive. This tangible evidence of DUXBAK performance is at the plant of Seabury and Johnson, Orange, N. J. This drive is of the flexible idler type and is an unusually trying one.

DUXBAK BELTING TRADE MARK

Chas. A. Schieren Company ESTABLISHED 1868

Tanners
Belt Manufacturers

Main Office and Factory
72 FERRY STREET NEW YORK

Chas. A. Schieren Company of Canada
Montreal: **711 St. James Street**
Toronto: **64-66 Front Street, West**

Try to break the DUXBAK . . . We'll send you a sample

This is the test. We'll send you a sample of Duxbak Belting, known to belt users everywhere. Try and break it. Bend it any way you please. *Treat it rough!*

Note its unusual pliability. Rub it around on your desk and see how it clings to the surface. Then imagine a whole length of Duxbak running on your pulleys.

The coupon brings the famous duck. Mail it today and try this test.

CHAS. A. SCHIEREN COMPANY
72 Ferry Street, New York, N. Y.
You may send me a sample of Duxbak. I'll try to break its back.

Name .....
Position .....
Company .....
Address .....

From BRONZE *comes the Ideal* BEARING

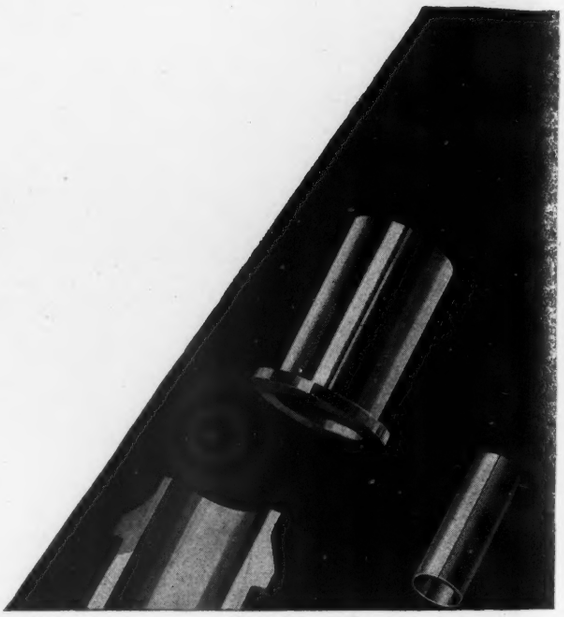
FROM bronze comes the ideal bearing for most installations, not only from the standpoint of utility, but because bronze bearings contribute so substantially to lower costs for machinery and vehicle builders and users.

Bearings made of bronze fulfill their functions satisfactorily over an almost unbelievable length of time. They cost materially less initially, and present no expensive maintenance problem.

So widespread has the use of bronze bearings become, the task of producing them constitutes in itself a major division of industry. Johnson Bronze, alone, as a specialized bronze bearing manufacturer, now numbers its production in millions of units.

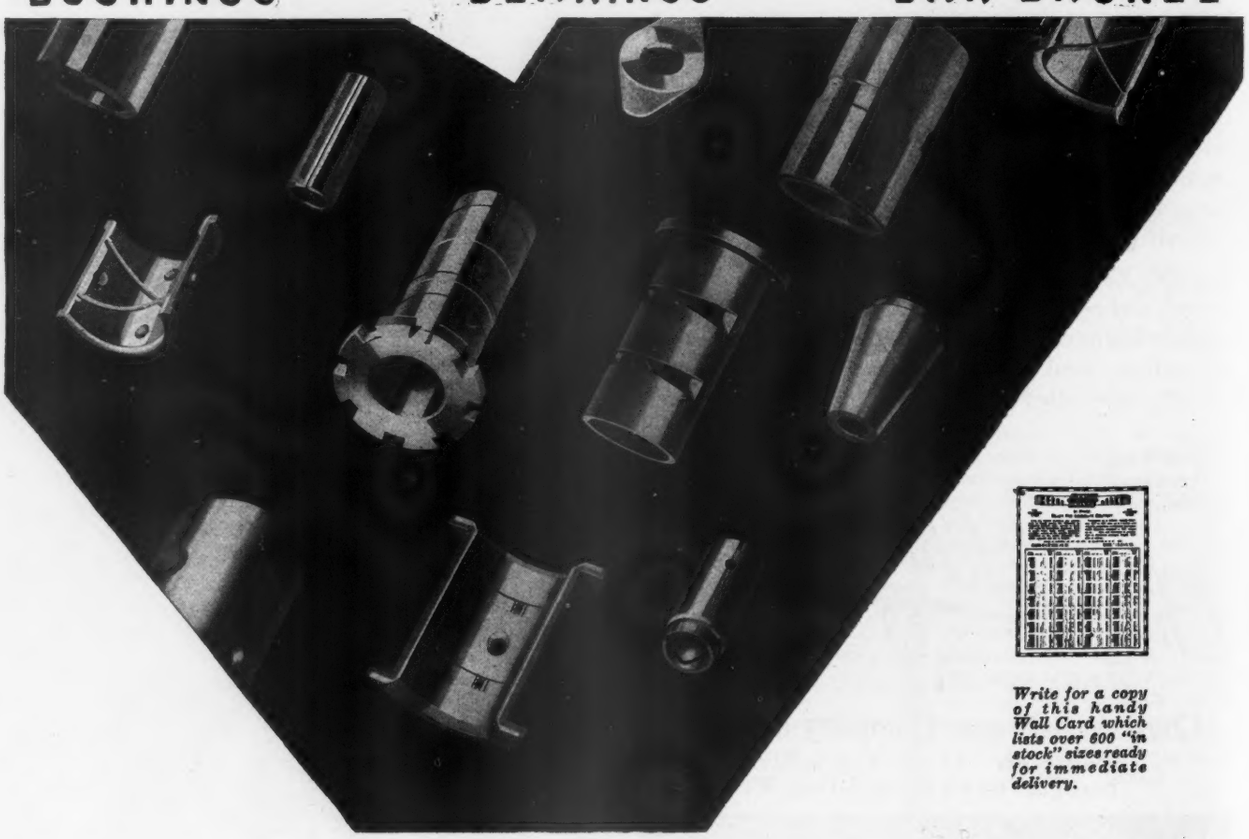
For over a quarter century, Johnson Bronze has served successfully every section of industry with all or a material part of its bearing requirements.

JOHNSON BRONZE COMPANY
NEW CASTLE, PA.
Branches
New York Chicago Philadelphia Detroit
Cleveland Kansas City San Francisco



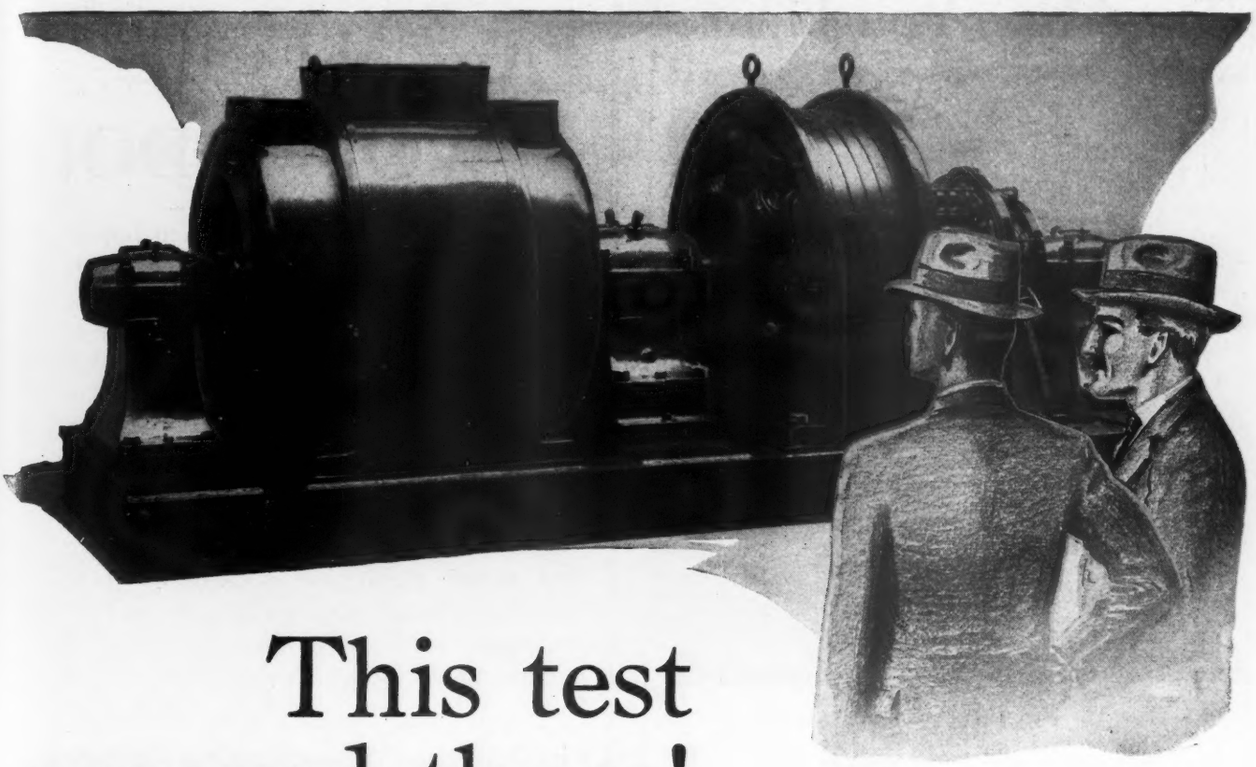
JOHNSON BRONZE

BUSHINGS BEARINGS BAR BRONZE



Write for a copy of this handy Wall Card which lists over 600 "in stock" sizes ready for immediate delivery.

ELLIOTT for Motor-Generators



This test amazed them!

A group of prospective purchasers was observing the test of a 300-kw. set in the ELLIOTT shops. Step by step the normal load of 1090 amperes was increased—to 1500 amperes—to 2000—to 2500 and then finally to 3000 amperes, and held there for five minutes. 175% overload, and the ELLIOTT Motor-Generator set gave no sign of distress!

Sound design, exceptionally generous factors of safety, good, clean, careful manufacturing — without these ELLIOTT equipment could never have built the unusual reputation it has for unfailing service under the most trying conditions.

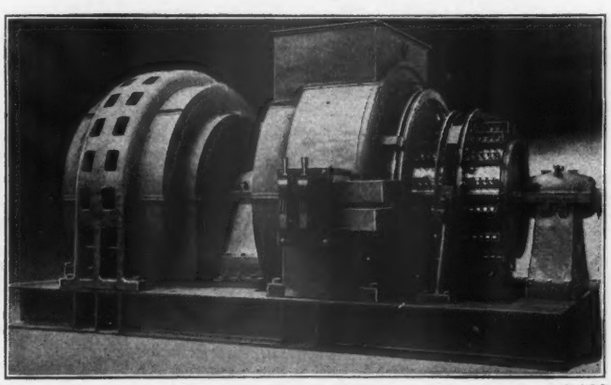
If you are interested in motor-generator sets that are rugged, economical, and competent, investigate Elliott.

ELLIOTT COMPANY
PITTSBURGH, PA.
General Sales Offices **JEANNETTE, PA.**
District Offices in principal cities

Elliott Power Equipment includes engines, turbines, motors, generators and electrical machinery, condensers, deaerators, heaters, centrifugal blowers and accessory equipment.

[An overload of almost three times normal load could not distress this ELLIOTT Motor-Generator Set.]

Elliott Motor-Generator Sets are built in a complete range of sizes, up to the largest. A 1500-kw. Set is illustrated below.



O-928

The More You Figure

The More You'll Agree

That VIM Shows

"Truly Remarkable Performance"

FOR years belt slippage robbed industry of its most costly possession—"horse power." Every manufacturer of belting insisted that "his" belt wasn't one of the offenders—and, of course, nobody believed him.

Finally came the trial—impartial—decisive. Belt slippage tests were conducted by the Engineering Experiment Station of Ohio State University on every brand of transmission belt of any importance. The State of Ohio paid for the tests and manufacturers were told to "keep out."

The verdict was decisive. In the words of the experimenters, "a mineral tanned leather belt of high quality showed a truly remarkable performance." The belt referred to has since been shown to be VIM.

Figure out the slippage of belting in YOUR plant. You will find that oak tanned leather belting slips five times as much as VIM.

VIM saves h.p.—gives more r.p.m. to the driven pulley, and increases production wherever it is installed.

E. F. Houghton & Co.

Philadelphia, Pa. ***And All Over the World***

C27-84

"Any old wire WON'T DO!

A dependable power supply is so important to industry that exacting engineers carefully choose their lubricating oils, their belting materials, their bearings, their fuses and most of the materials that have anything to do with power.

Why not be equally exacting about electrical wires and cables? Power, lighting, signalling and electrical controls depend upon them. Failure of insulation can tie up major production units and incur enormous expenses. It is the poorest economy to use anything but insulated conductors of *proven* reliability.

For half a century OKONITE has proven its dependability in the toughest service. The railroads have used it extensively. The public utilities rely upon it. And many an important industrial plant has learned that it pays handsomely to insist upon OKONITE for all wiring. Ask us for specific information.

OKONITE PRODUCTS

OKONITE INSULATED WIRES AND CABLES
VARNISHED CAMBRIC CABLE
OKONITE INSULATING TAPE
MANSON & DUNDEE FRICTION TAPE
OKONITE CEMENT
OKOCORD
OKOLOOM

OKONITE-CALLENDER PRODUCTS

SUPER-TENSION CABLES
IMPREGNATED PAPER CABLES
SPLICING MATERIALS

The Okonite Company

FOUNDED 1878

The Okonite-Callender Cable Company, Inc.

Factories: Passaic, N. J., Paterson, N. J.

Sales Offices: New York Chicago Pittsburgh, St. Louis Boston Atlanta Birmingham San Francisco Los Angeles Seattle Dallas

Novelty Electric Co., Philadelphia, Pa.
F. D. Lawrence Electric Co., Cincinnati, O.

Canadian Representative:
Engineering Materials Limited
Montreal

Cuban Representative:
Victor G. Mendoza Co.
Havana

OKONITE QUALITY CANNOT BE WRITTEN INTO A SPECIFICATION

⟶ 6,853 ⟵

LEADING INDUSTRIAL CONCERNS were using - - - - - -

MARTINDALE COMMUTATOR STONES

On the Day This Ad Was Written

WATCH the number of users mount up in next month's issue of *Industrial Engineering.*

You will be insured of most satisfactory commutation by the occasional use of Martindale Stones.

FILL IN and MAIL this coupon for complete information and prices

THE MARTINDALE ELECTRIC COMPANY

Cleveland, Ohio U. S. A.

The Martindale Electric Co.
1252 W. 4th St., Cleveland, Ohio, U. S. A.

Send me complete information and prices on Martindale Commutator Stones.

Name and Title.....

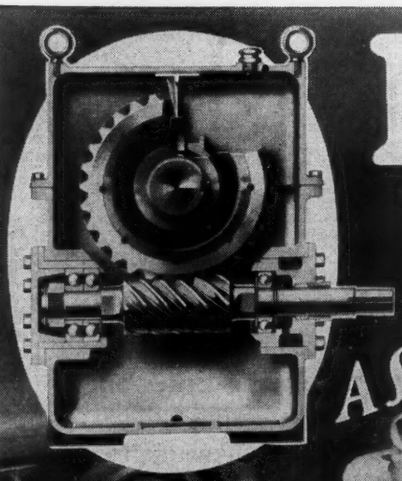
Company.....

Street.....

City.....*State*.....12-29

De Laval Worm Gear

A Superior Speed Reducer for difficult drives



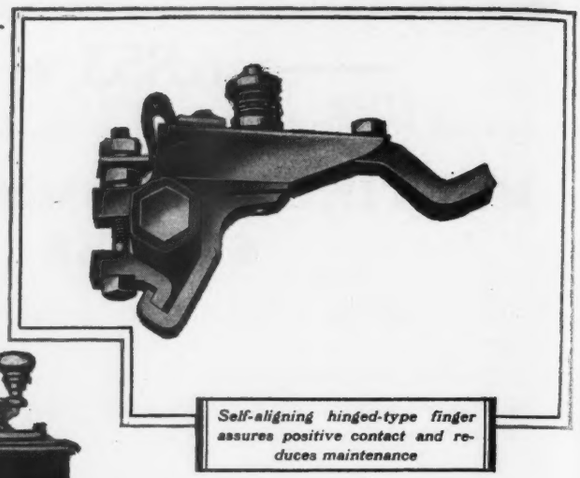
THESE 50 to 1 ratio gears are transmitting 5 h.p. each from 690 r.p.m. motors to 36 in. apron feeders in a copper smelting plant.

De Laval Steam Turbine Co., Trenton, N.J.

2996

AD-1010

Operating handles—vertical, horizontal, or rope-operated with spring return—are interchangeable



Self-aligning hinged-type finger assures positive contact and reduces maintenance

Strong-easily maintained-safe G-E Drum Switches

RIGID frames of great strength; removable covers for easy access to all parts; conduit boxes which permit leads to enter from back, front, or sides; easily operated; totally enclosed; thoroughly safe—these are among the features which have made G-E drum switches leaders in the industrial field.

The cylinders can be removed for repair or replacement without disconnecting a single wire; and self-aligning hinged-type fingers with easily renewable tips afford long life and even contact regardless of wear.

Controllers
—guide and conserve industry's power

301-45

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

STEELTUBES [E. M. T.]* has the same inside diameter as heavy conduit. Made in three sizes [½", ¾" and 1"] with diameters and wall thickness shown above. One coupling furnished with each ten-foot length

BEFORE *and* AFTER
...an object lesson in corrosion

THE pictures tell the story. Two pieces of conduit—before a 96 hour 5% sulphuric-acid test [in the circle]. *After* the test in the larger view. STEELTUBES [E. M. T]* at the left in both.

Note the corrosion of the Bessemer steel in the heavy conduit and the resistance offered by the close-grained, cold-rolled, openhearth steel of STEELTUBES. Hardly a trace of corrosion after a test equivalent to years of exposure. It is this corrosion resistance of the basic metal itself which makes STEELTUBES such a marked improvement.

Have you seen a sample of STEELTUBES? Let us send you one, so you can make this test for yourself.

Electrical Division
STEEL AND TUBES, INC.
Cleveland, Ohio
(A subsidiary of Republic Iron & Steel Co.)

10

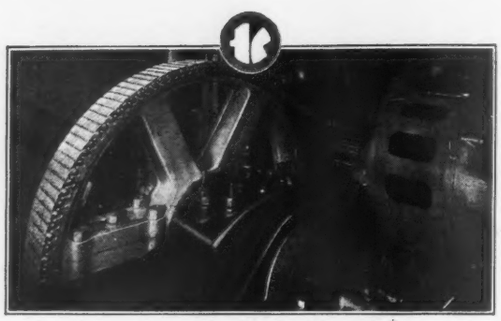
STEELTUBES Advantages

1—Saves thread-cutting
2—Bends easily
3—Light—handles easily
4—Takes any fitting
5—Speeds up the job
6—Resists corrosion
7—Costs less
8—Standard price
9—Carries Underwriters' Label
10—Local stocks always available.

*STEELTUBES Electrical Metallic Tubing is threadless, strong, light and easy to handle. Costs less to buy. Saves time and money on the job.

Steeltubes

Dependable Power with MORSE CHAIN DRIVES



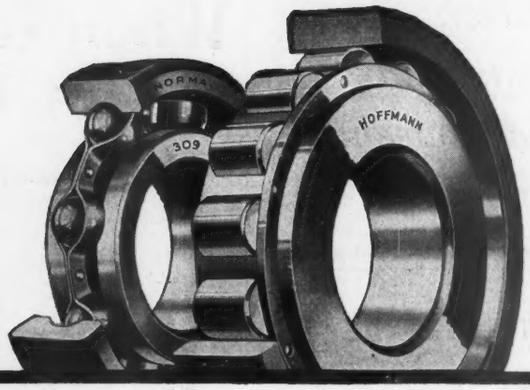
MORSE SILENT CHAINS as installed in the refrigeration plant of The Arena Gardens, Montreal, Canada.

For dependability in power transmission, your plant should have Morse Silent Chain Drives. They keep the wheels of industry turning year in and year out, with a minimum of repair and upkeep expense. They transfer your power from the prime mover to the point of use—smoothly, silently, efficiently. The foremost engineers, and the greatest industries of the country choose them because of their proven advantages over any other form of power drive. And once installed in your plant, they will make money for you through lowered overhead, efficient transmission of power, reduced manufacturing costs, and better work done by machines that run at their best.

Morse engineers are always waiting to serve you. A complete file of data on power transmission that is of interest to every business man, every factory maintenance man, and every engineer will be sent you on request. Write for it.

MORSE CHAIN CO.
ITHACA, N. Y.
Branches In Principal Cities

MORSE SILENT CHAIN DRIVES



PRECISION

... its meaning and its commercial value ...

PRECISION, as commonly used, is a term defining extreme refinement of dimension and finish. But as describing an outstanding quality of *NORMA-HOFFMANN Precision Bearings*, the word has a far more comprehensive meaning.

To Norma-Hoffmann engineers and production men, *Precision* means the ultimate in dimensional refinement. Above and beyond this, however, it means bearing design worthy of expression in a finished product of this extreme refinement—selected materials well deserving of special treatments and of highly refined machining processes—standards of production which permit no deviation from absolute uniformity, regardless of quantity.

Precision, as thus described, is the foundation quality upon which the Norma-Hoffmann reputation rests, upon which its business has been built, and upon which it must continue to grow.

But what does all this mean to the buyer and user of *NORMA-HOFFMANN Precision Ball and Roller Bearings?* What, in other words, is the commercial value of *Precision?*

Briefly stated, *Precision* stands for that combination of qualities which manifests itself in higher anti-friction efficiency, longer life, greater speedability, better performance, lower costs for replacements, increased production. These are the distinct and concrete advantages which accrue to the user of *NORMA-HOFFMANN Precision Bearings.*

Obviously, *Precision* is costly to produce and to maintain. But it has been the uniform experience of those who have availed themselves of its advantages, that its price is repaid a hundred fold in the lower after-costs which inevitably follow.

The long, varied experience of Norma-Hoffmann engineers is offered without obligation to machine users and builders facing bearing problems.

NORMA-HOFFMANN
PRECISION BEARINGS

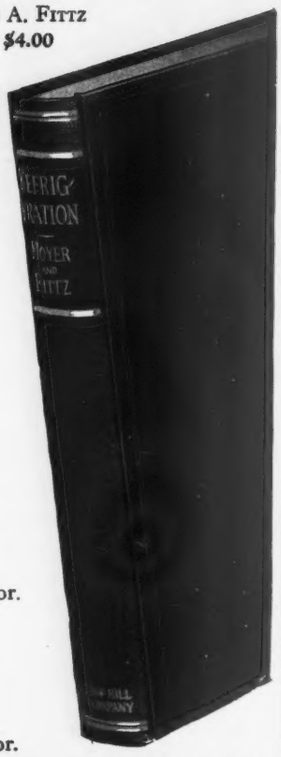
NORMA-HOFFMANN BEARINGS CORPN.—STAMFORD CONN. U.S.A.

The theory, operation and testing of modern commercial and household refrigerating machines - - -

Refrigeration

Including Household Automatic Refrigerating Machines

By JAMES A. MOYER and RAYMOND A. FITTZ
431 pages, 6x9, 184 illustrations, $4.00



A thorough treatment of the theory, operation and testing of modern refrigeration systems, for:

—the operating Engineer in refrigeration plants

—the mechanical Engineering student

—the man engaged in servicing and installing household refrigerating equipment.

Complete Information on:—

The Air System.
The Compression System.
The Absorption Ammonia System.
The Vacuum System.
The Vap-Air System.
The Audiffren-Lingrun Refrigerator.
General Electric Refrigerator.
Frigidaire.
Kelvinator.
Welsbach.
"Icyball."
Electrolux Servel Gas Refrigerator.

The book begins with a thorough explanation of refrigeration methods and systems of refrigeration. It discusses the theory of refrigeration and the chemistry of the subject. The various types of equipment are described in detail and their operation and testing carefully explained. Household Automatic Refrigerating machines receive special attention. Particularly interesting also, are the discussions of ice making, cold storage construction, air conditioning and cooling and the cold storage of foods.

Send for this book today. Use it for 10 days FREE.

McGraw-Hill

FREE EXAMINATION COUPON

McGraw-Hill Book Co., Inc., 370 Seventh Avenue, New York.

You may send me on 10 days' approval Moyer and Fittz—Refrigeration, $4.00 postpaid. I agree to remit for the book or return it postpaid within 10 days of receipt.

Signed.....
(Please Print)

Address.....

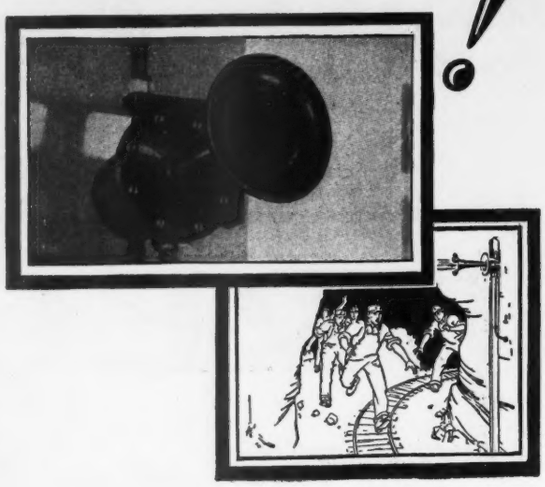
City and State.....

Official Position.....

Name of Company.....

(Books sent on approval to retail purchasers in the U. S. and Canada only.) **I.E.-12-29**

When You Want Him it GETS Him!



BENJAMIN Motor Driven Signal

When an industrial signal is rapped out, any old time won't do to answer. It must command instant and undivided attention. It must demand an instant response.

Something is happening; someone is waiting. And usually the party or the department signaled is busy and it is hard to break through.

But you cannot neglect a Benjamin motor-driven signal. The deep, distinct, penetrating note crashes through industrial noises. It GETS the man, where bells, buzzers and gongs would be futile.

Admirably adapted for code signaling. For either indoor or outside locations. Needs no attention; automatically lubricated. A thoroughly dependable signal for continuous or intermittent use.

Send for our new illustrated folder on the many fine features of the Motor-Driven Howler

Benjamin Electric Mfg. Co.
General Offices and Factory
DES PLAINES
(Chicago Suburb)
ILL.

NEW YORK CHICAGO SAN FRANCISCO

"Not a light in the place except this pinwheel!"

You don't realize how good you want commutators to be, until you have had one "go bad" and cut off the power and light from a busy plant that's trying to work night shifts.

DEPENDABILITY is built into EUREKA Commutators, because we do know how important it is. The *best* of materials and workmanship are just *good enough* at "EUREKA".

We also understand that when you order electrical parts in a rush, you want them soon. One new customer after another has written us in pleasant surprise about deliveries made in a half to a quarter the time expected.

Only the finest pure copper is used in our segments — and the best grade of mica insulation. Accurate workmanship is guaranteed in every commutator we build.

Try us for Commutators, Commutator Bars. Brush Holders, either standard or special. Copper leaf and Gauze Brushes. Collector Rings and Soles. Controller fingers, segments, field plates, etc. Trolley wheels, Collector wheels, etc. Axle Bearings and Journal Brasses. Line Material. Switches. Copper and brass washers, and nuts. Copper Hammers, etc.

You will like the High Quality of EUREKA parts, the Prompt Service—and Reasonable Prices too.

EUREKA METAL PRODUCTS CORPORATION
79 Clay Street North East, Pa.

"You'll say: EUREKA! I've found it: Prompt service, high grade electrical parts, and reasonable prices."

THE PRODUCT of 24 YEARS' EXPERIENCE

Palmer-Bee Herringbone Speed Reducers are backed by 24 years' experience in the power transmission field.

They embody every improvement and refinement known to engineering science.

Precision cut continuous tooth steel herringbone gears, mounted on alloy steel shafts, transmit the power silently, without vibration or appreciable wear.

Ball, Hyatt and Timken Bearings diminish friction to a minimum and help to produce an all-around efficiency of 98 to 99%.

Symmetrical arrangement of gears insures a balanced drive and uniform load on bearings.

Oversize shafts and bearings permit overhung loads up to maximum capacity of reducer.

Nelson Patent Oil Seals prevent oil leakage.

A massive cast iron housing, tapered to insure utmost rigidity, keeps the gears in permanently accurate alignment.

A positive lubrication system minimizes wear.

Our Catalog No. 50 describes in detail the many exclusive construction features of Palmer-Bee Reducers. It contains tables of horsepower ratings and dimensions, as well as instructions regarding the selection of the proper size reducer, the correct method of installation and maintenance. Write for it.

PALMER-BEE COMPANY
1701-13 Poland Ave. Detroit, Mich.

Do you think it's

Too Good to be True?

Every plant superintendent has dreamed of the time when his plant would be trouble-proof

YES, your plant can be made trouble-proof as far as the flexible couplings are concerned. Flexible coupling troubles can actually be made a thing of the past.

What is it that causes coupling shut-downs in your plant? Almost invariably replacing broken springs, rings, bushings, pins, discs or grids—flexible materials that fatigued and failed. Eliminate the flexible materials and the problem is solved!

How? Fast answered that question. As the diagram below shows, two spur gears are in complete and continuous mesh with the internal gears of a floating sleeve. The sleeve takes a neutral position, the error in misalignment is taken up between the lubricated faces of the gear teeth, and all necessity for flexible materials is eliminated.

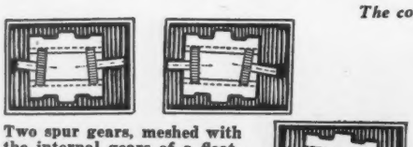
It has been demonstrated mathematically, experimentally and in actual operation of tens of thousands of couplings that there is no metal-to-metal contact between the gear teeth. The oil in the sleeve, under the centrifugal pressure due to revolving of the shafts, is thrown between the faces of the gear teeth, providing an actual oil cushion that carries the load.

If you are purchasing new equipment—or if you have a danger drive with which you have recurring coupling troubles—let us know. Tell us the kind of equipment, the kind of service, the H. P., the R. P. M., and the shaft diameters, and we will submit prices at once. You will be surprised to find (in most cases) that the cost of the Fast's Coupling is little if any more than the old style. But the difference in performance is so marked that Fast's Couplings are always cheapest in the end.

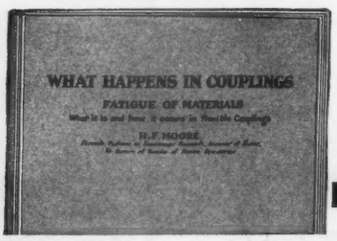
Also do not fail to send the coupon for the extremely illuminating book by Prof. Moore on "What Happens in Couplings." It's valuable, but it's free. Send for it.

FAST'S
Self-Aligning
COUPLING

The coupling without flexible bushings, pins, springs, discs, grids or any other flexible materials.



Two spur gears, meshed with the internal gears of a floating sleeve. Coupling revolves as one unit, misalignment being taken up between the lubricated teeth.



Get this authoritative book which clearly shows how flexible materials can be avoided in coupling design.

Sign and mail this Coupon for the Free Book.

THE BARTLETT HAYWARD CO.

201 SCOTT STREET - - - BALTIMORE, MARYLAND

Read Prof. Moore's authoritative discussion of the failure of flexible materials.

*Company*_____ *Individual*_____

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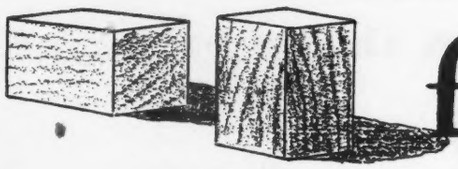
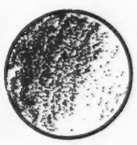
In Speed Reducers—
are YOU Buying

square pegs

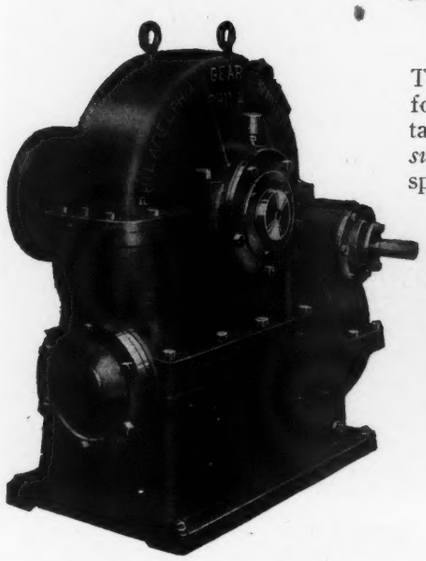


for

round holes



To get the RIGHT type of speed reducer for a given machine or drive is as important as the machine itself! There is one *sure* way of getting the RIGHT type of speed reducer—and that is to get



Philadelphia
SPEED REDUCING UNITS

(ONE NAME—ALL TYPES)

We have added to our line of standard Speed Reducers — Continuous Tooth Herringbone Gear Units, in which the gears are of the SYKES TYPE — made of high carbon or alloy steel. The helix angle is 30°, which assures maximum tooth overlap and smooth, silent running. Maximum strength of teeth is secured by the unbroken tooth surface. These units have a high factor of safety and efficiency which they will maintain indefinitely. They are sturdy and are recommended for heavy duty and continuous work.

Come to "headquarters"! Come where you can get thoughtful advice free from "sales-prejudice" in favor of any one specific type.

Making all types, we need not "push" any one kind, over the other. We work with you, helping you select the right type—worm, spur, herringbone, spiral-bevel-herringbone, etc. You are assured of correct speed reduction for slow speed or high speed drives—right angle, horizontal or vertical. And, having selected the type—you can be certain of what's inside the sealed housing—long years of life, perfect power transmission, power loss practically nil.

Let us tell you with what care Philadelphia Speed Reducing Units are built—each type a specialized job. *Write for Bulletins now.* Send us that next ORDER!

PHILLIE GEAR

Power Saving Products

GEARS, Spur, Worm, Herringbone, Internal, Bevel, Miter, Intermittent, Spiral, Helical, Continuous Tooth Herringbone Gears.
NON-METALLIC PINIONS: Fabroil, Textolite Rawhide.
Ground Thread Worms, Whitney Silent and Roller Chains, Sprockets, Flexible Couplings, Universal Joints, Racks, Ratchets and Pawls, and a complete line of gear driven
SPEED REDUCING UNITS

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Manufacturers of Industrial Gears and Speed Reducing Units

PHILADELPHIA, PENNA.

Branch Sales and Engineering Offices:
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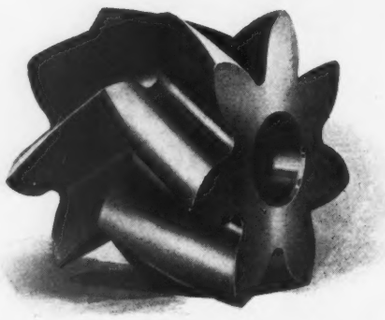
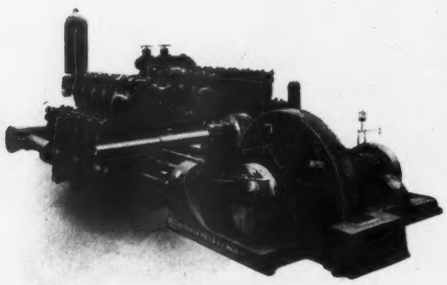
Detroit—Donovan Bldg.

Farrel Sykes Gears

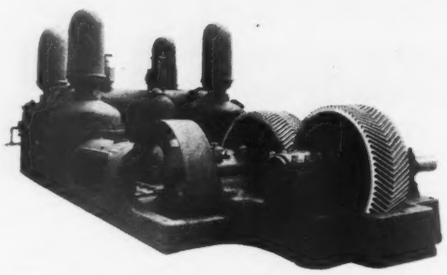
are applicable wherever power is transmitted between shafts on parallel axes



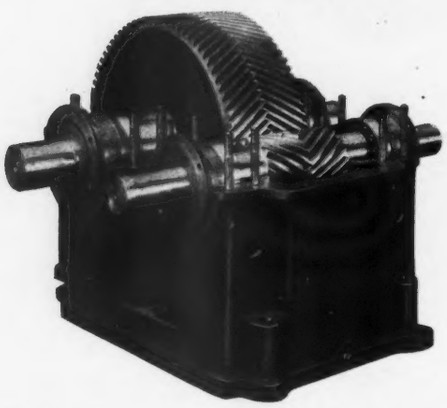
They Operate Smoothly and Quietly and Have from 10% to 40% More Bearing Surface Than Other Types of Double Helical Gears

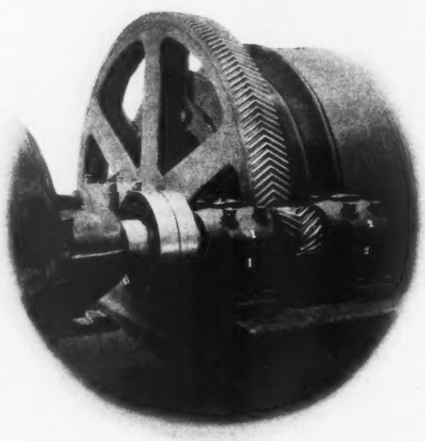


Goulds Pumps are fitted with Sykes drive gears.



Worthington Reciprocating Pumps are often fitted with Sykes drive gears.





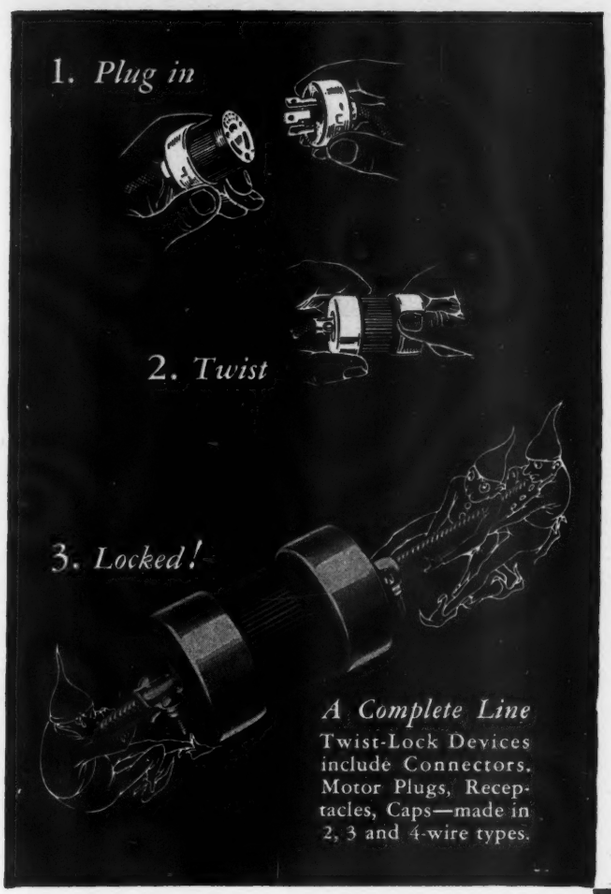
Ottumwa Hoists are all Sykes gear driven.

FARREL SPEED REDUCERS

Sykes gears are applied in a series of speed reducers of over a hundred different designs and suitable for transmitting powers from 1 H.P. to 5000 H.P. and ratios from 1/1 to 300/1.

FARREL-BIRMINGHAM CO., Inc.

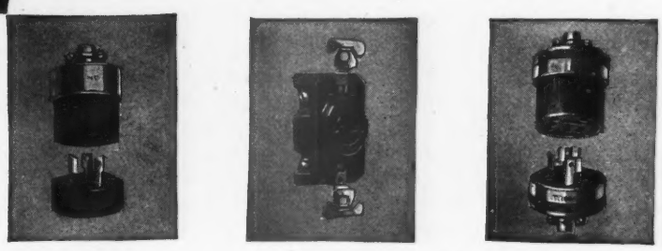
SUCCESSOR TO
FARRELL FOUNDRY & MACHINE CO., ANSONIA, CONN., AND
BUFFALO, N. Y., AND BIRMINGHAM IRON FOUNDRY OF DERBY, CONN.
ADDRESS REPLIES TO THIS ADVERTISEMENT TO BUFFALO PLANT
344 VULCAN ST., BUFFALO, N. Y.


1. Plug in
2. Twist
3. Locked!
A Complete Line
Twist-Lock Devices include Connectors, Motor Plugs, Receptacles, Caps—made in 2, 3 and 4-wire types.

In *your* plant..

Stop disconnection delays with these Twist-Lock Devices

3 and 4-Wire Twist-Locks protect against electrical hazard, too . .



If you are interested in keeping machines humming and production moving, you will be interested in Twist-Lock Devices. For these devices stop the "minute-here, two-minute-there" delays that occur when a connector parts or a cap slips from its receptacle.

A Twist-Lock Device guarantees a lock-fast connection as long as desired. Just plug-in and twist the cap for a connection secure against pulls, vibration and rough handling.

Install Twist-Locks to stop accidental disconnection in your plant...Install 3 and 4-wire Twist-Locks and your workmen who operate portable motor-driven tools or electrically operated appliances, will be positively protected against electrical hazard.

Use the coupon to obtain full information and the helpful new Hubbell Grounding Chart.

HARVEY HUBBELL, INCORPORATED
BRIDGEPORT : : CONNECTICUT

HUBBELL

HUBBELL *Twist-Lock* Devices

Mail Coupon to our nearest office

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Garnett Young & Co.

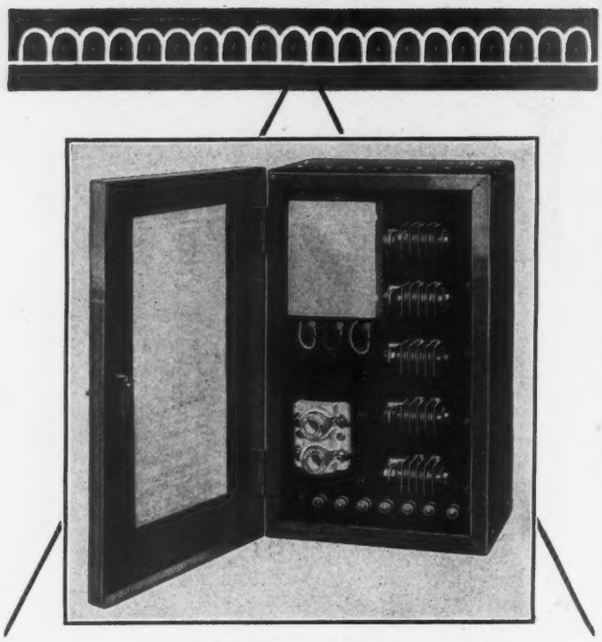
Please send information on Hubbell Twist-Lock Devices

Name_____

Address_____

I.E.12-29

City and State_____



B-L Rectifier Assembly
for
TIME CLOCK SYSTEMS
SIGNAL SYSTEMS
RECORDING SYSTEMS

Progressive manufacturers are always on the lookout for new and improved methods.

The type B-12-S-5 Rectifier Assembly illustrated above, eliminates the unnecessary cost and inconvenience of the old 'battery-transformer' power source used for the operation, of *Electric Time Clocks, Signal Systems,* etc.

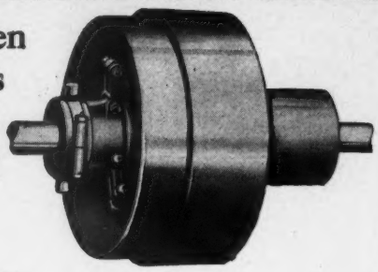
This assembly is complete with transformer, fuse block and terminal leads, and is enclosed in an approved steel cabinet.

A card will bring complete detailed information

The B-L Electric Mfg. Co.
(Formerly Mfg. Division Benwood-Linze Co.)
19th and Washington St. Louis, Mo.

B-L RECTIFIERS

Motor Driven Head Shafts Require High Speed Friction Clutch Cutoff Couplings



For a large flour mill, specifications call for—
300 H. P. at 580 R. P. M.
100 H. P. at 695 R. P. M.

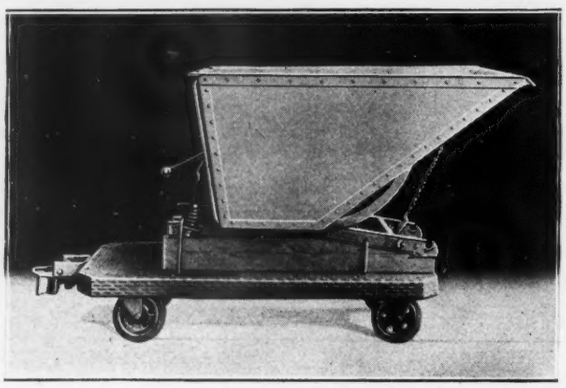
"Moore & White" High Speed Friction clutch cut-off couplings were selected—
Two 25-in. size, with six bronze discs
Two 17-in. size, with four bronze discs

These clutches have one point of adjustment and pick up the load gradually from rest.

Send for Friction Clutch Catalogs

1. High Speeds
2. Moderate Speeds
3. Double Discs
4. Steel Pulleys

The MOORE & WHITE COMPANY
2709-39 North 15th St.
PHILADELPHIA, PA.
"Friction Clutch Manufacturers for 44 years"



Clark Trailer (Code: "Chips"). Hopper body of 24 and 30 cu. ft. Capacity on 1 or 2-ton trailer chassis. Overall height, 53 in.; length, 89 in.; width, 41¼ in.

Clark Chip Trailer
Systematizes Clean-Up on Low Cost Level

"Chips" handles coal, ashes, refuse,—any bulk material,—but serves as nothing else can when scrap loads are to be collected from several stations. Placed at aisle intersections in factories and shops this dump-body trailer accumulates refuse until picked up by tractor. Dumps clean, spotting its load directly into the freight cars or on the dump heap. Secure full details by clipping this ad and sending it with your name and address to

CLARK TRUCTRACTOR COMPANY
Battle Creek, Michigan

Send For This Handbook Today

Flexible Couplings

How to judge them
How to compare them

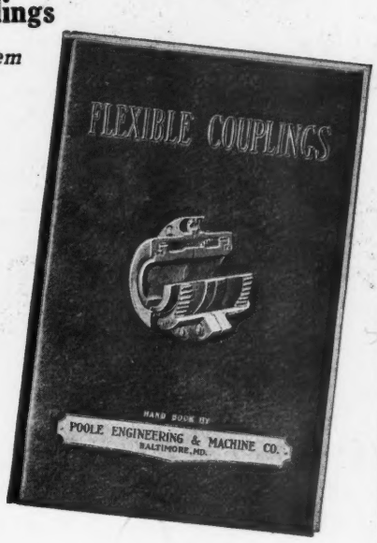
Also describes

The Poole Flexible Coupling

(Fully Patented)

You will find this book

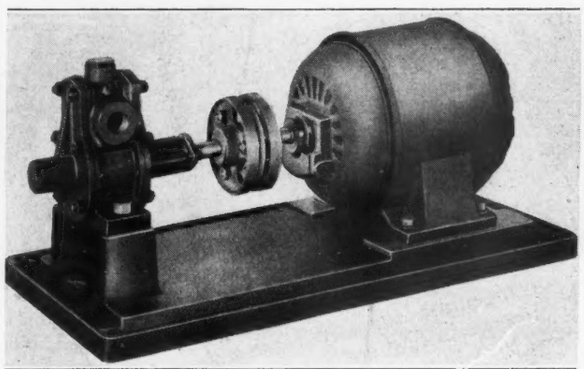
INVALUABLE
INTERESTING
INDISPENSABLE



Send for your copy today

Poole Engineering & Machine Co.
Baltimore, Md.

INHERENT BALANCE



Vibration virtually vanishes when Flexoid Couplings are used. The coupling bolts solid to a specially designed, flexible disc. There are no working parts. Shocks are absorbed. Balance is inherent.

Flexoids need no lubrication, are unaffected by water oil or grease, meet all A. S. M. E. Safety Code requirements. Order some for trial.

The Smith Power Transmission Co.
1213 W. 3rd St., Cleveland, Ohio

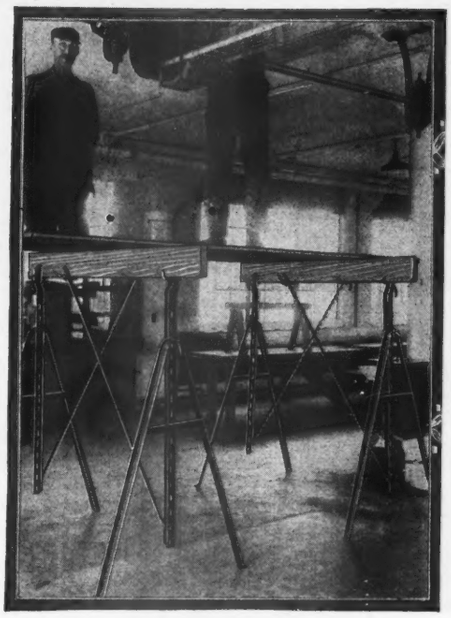
The Smith Mark Shows It's a Genuine (PST) *Flexoid*

Trouble Saver

Adjustable Trestles

(PATENTED)

A Safe, Sure, low-cost method for **handling all overhead jobs**



(View of Trouble Saver *Adjustable Trestles in the Millwright Department of THE LUFKIN RULE COMPANY, Saginaw, Michigan.*

SAFE—because they are sturdily constructed and make a firm, non-collapsible trestle. SURE—because they can be used for all overhead work and will straddle machinery and equipment. LOW-COST—because they NEVER WEAR OUT . . . are always ready . . . require only a few minutes to set up . . . absolutely fool-proof . . . and they fold compactly for storage.

Mail the coupon below for full information on this up-to-date scaffolding and details of our 30 day FREE Trial Plan.

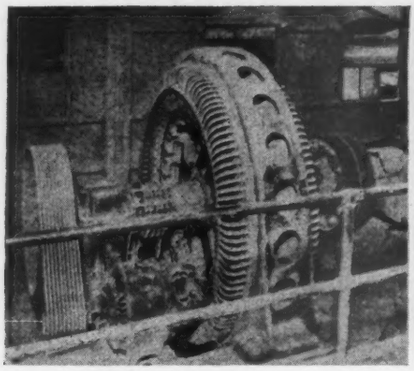
THE STEEL SCAFFOLDING COMPANY
1138 North Governor St., Evansville, Indiana

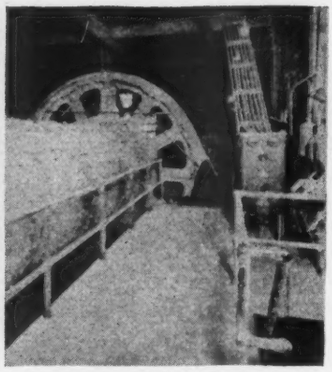
Please send me prices and full information on Trouble Saver Adjustable Steel Trestles. Also details of your 30 day Free Trial Plan.

Name.....

Address.....

Department.....





This 900-hp., 180-r.p.m., synchronous motor and the 8-ft.x35-ft. dry ballpeb mill for raw grinding, which it drives, are the largest units in the plant

Methods of solving

Power Drive Problems

in a cement mill

By A. C. BROWN
Plant Manager
Kosmos Portland Cement Co.
Kosmosdale, Ky.

FEW, if any, industries operate equipment under conditions worse than, or even nearly so bad as, those found in the modern cement plant. The severe operating conditions, such as dusty, abrasive atmosphere, high temperature, irregular and sho... pressures, ... are part... equipme... the c...

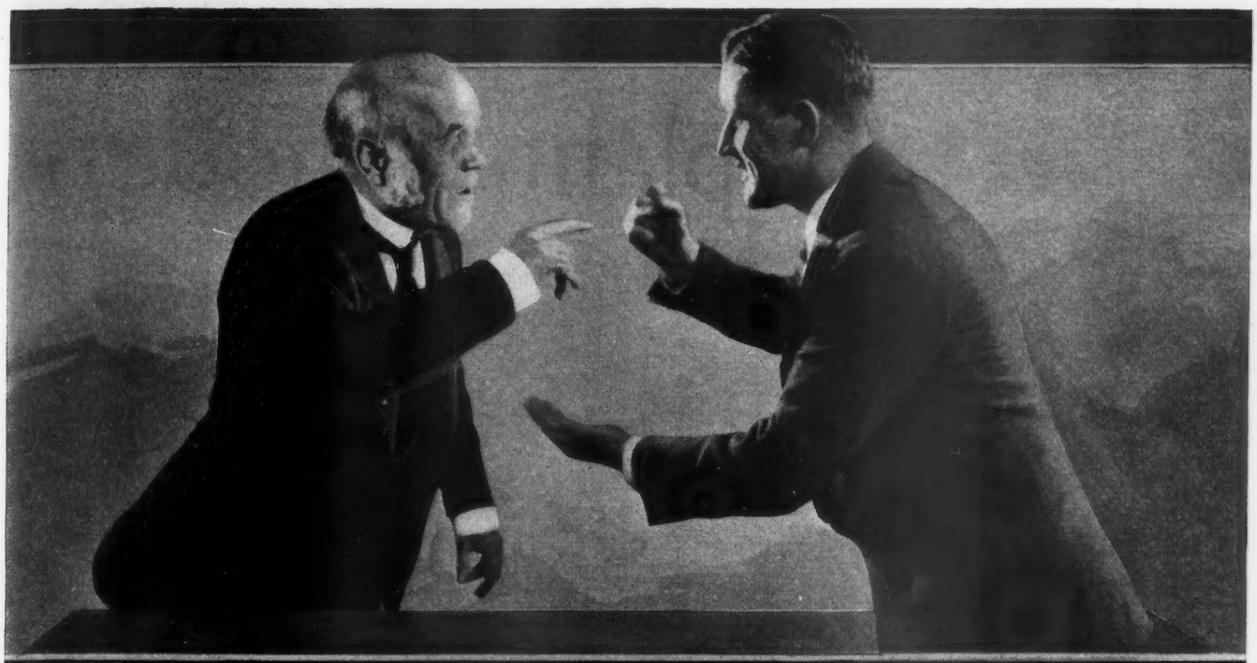
... of the plant. Idle equipment, or machines waiting for maintenance, do... will ... not make cement and consequ...

... and the renewal of interior ... the equipment exposed to th... action of the materi... Maintenance of pro... is a di... and ...

... parts, a... s not ... .s u...
a pinion or sprocket will not fit.
All new pinions are heat-treated and supplied by The Tool Steel Gear & Pinion Co. The longer life of the heat-treated pinions more than n... compensates for the extra cost be- th... cause of the greater freedom from di... interruption for changing pinions, as well as having only one installation dri... cost instead of two or three. Any a... equipment which lasts longer will compensate for any reasonable difference in first cost.
In addition to standardizing the

Cincinnati
"Tool Steel" Gears
the Standard of
QUALITY

The Tool Steel Gear & Pinion Co.
Cincinnati, Ohio



TRADITION **PROGRESS**

"Here, Lad—

You couldn't be so enthusiastic about 'Stable-Arc' welders if you didn't see something in them.

Just what DO you see?"

The Lincoln "Stable-Arc" Welder

— welds easier
— makes better welds
— permits greater output

because of the steady uniform arc throughout entire welding range, which is the result of:

Variable voltage design
Laminated magnetic circuit
Separately-excited generator field
Double control of welding heat
All steel construction

No other welder has all these features.

"Easy, Pop—

Sincerity is the first thing evident.

The arc welder is sold to a manufacturer who is expected to design his machinery for arc-welded production.

Now, the arc welder too is a piece of machinery.

If on the welder you see a welded frame generator driven by a welded frame motor, doesn't that inspire confidence in the sincerity of that welder maker's argument—viz: that you can build a thing better by arc welding.

The Lincoln 'Stable-Arc' welder is the answer since it's the most successful welder and is a *completely* arc-welded ensemble—motor, generator, frame, wheels and all.

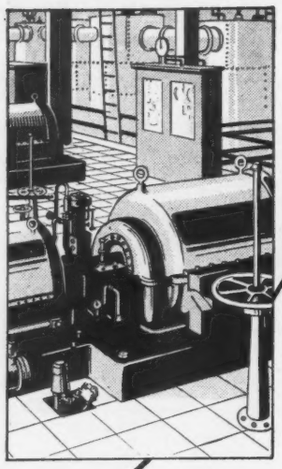
It's a welded union—not a mixed marriage."

The Lincoln Electric Co.,
Dept. No. 5-12, Cleveland, O.

"Stable-Arc"

LINCOLN WELDER

W-122



No plant is modern without efficient lubrication

MODERNIZATION of plant equipment is the order of the day. Modern equipment, however, no matter how high its rated efficiency will not live up to expectations without proper lubrication.

Continuous production and the service life of any machinery is directly influenced by the effectiveness of its lubrication. Improper lubrication causes stoppage of production that yearly costs industry thousands of dollars.

It is not always a simple task to determine which lubricants are best for each particular type of equipment. Usually to be certain what oil or grease will give most efficient lubrication requires a practical technical knowledge of machinery and also a complete understanding of lubricants.

Lubrication Engineers of the Standard Oil Company (Indiana) have this knowledge. They have at their disposal a complete line of the highest quality lubricants that it is possible to make.

An engineer from our nearest branch office will be glad to study your lubrication requirements—at no cost to you.

Hear the Chicago Symphony Orchestra every Sunday at 2 p. m., Central Standard Time, over the following stations:

WGN	Chicago
WWJ	Detroit
WTMJ	Milwaukee
KSD	St. Louis
WOC	Davenport
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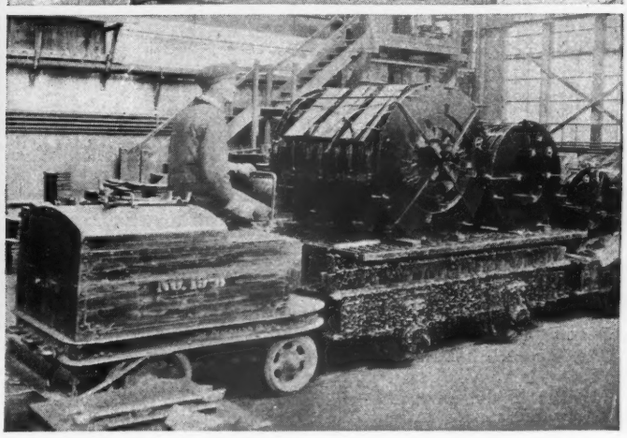

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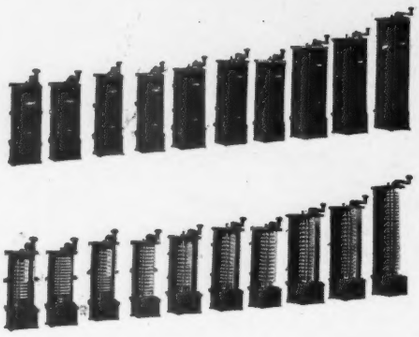

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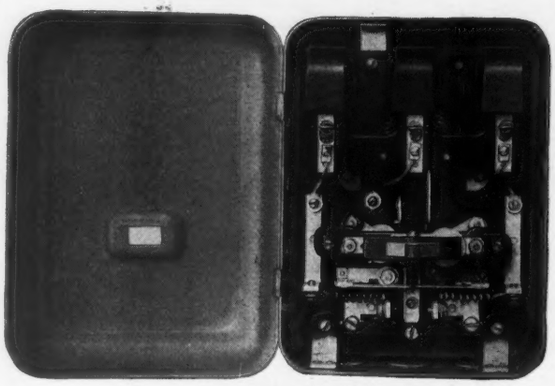

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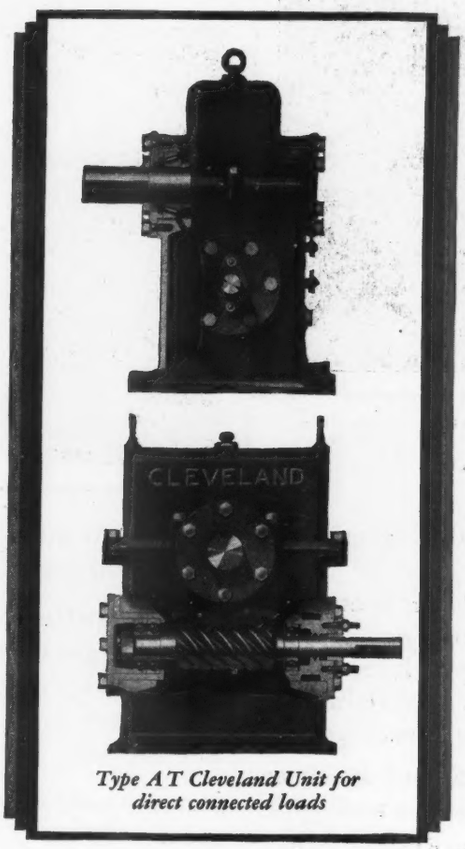

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You need ask only a few questions about Cleveland Worm Gear Speed Reducers to find evidence of the unusual care and precision which characterize their manufacture.

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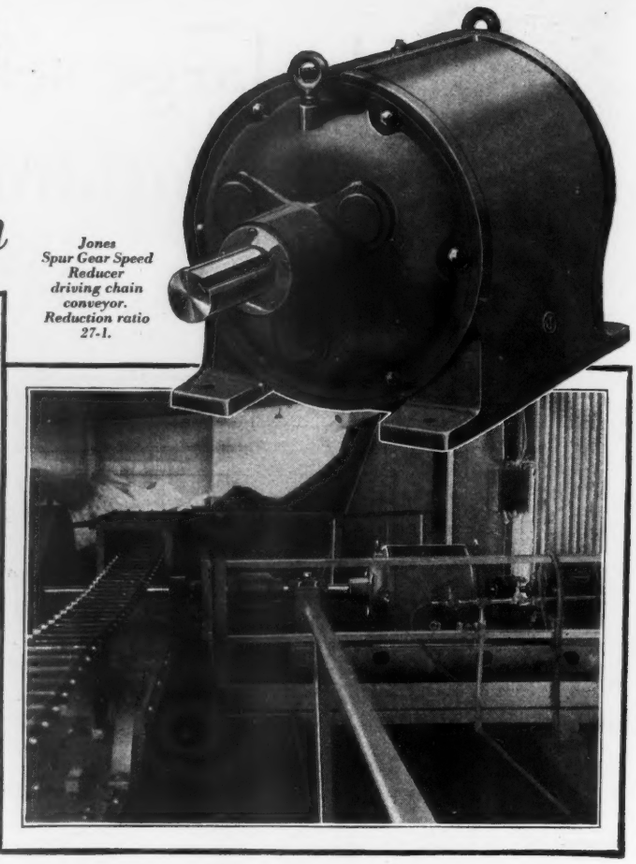
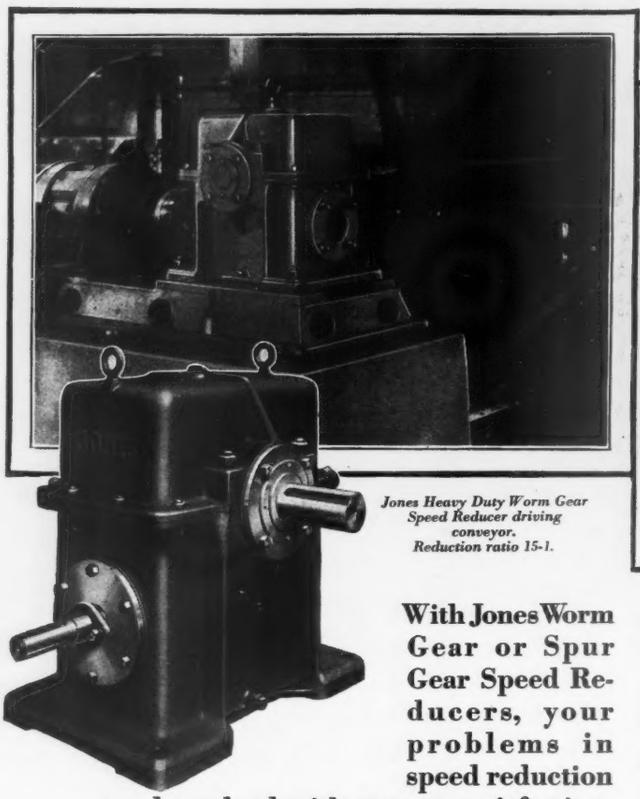


Jones Spur Gear Speed Reducer driving chain conveyor. Reduction ratio 27-1.



Jones Heavy Duty Worm Gear Speed Reducer driving conveyor. Reduction ratio 15-1.

With Jones Worm Gear or Spur Gear Speed Reducers, your problems in speed reduction can be solved with utmost satisfaction.

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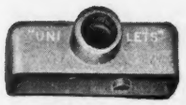

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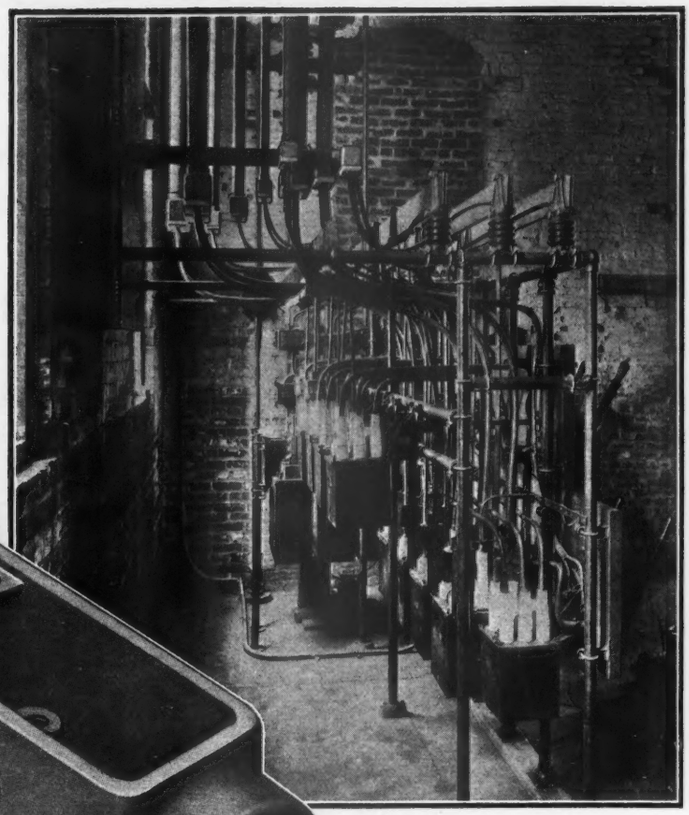

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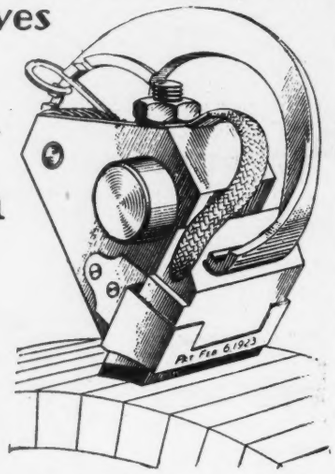

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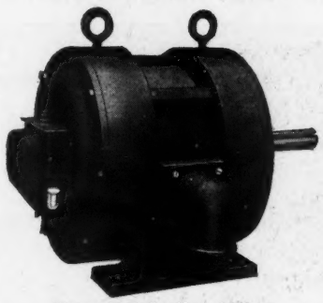

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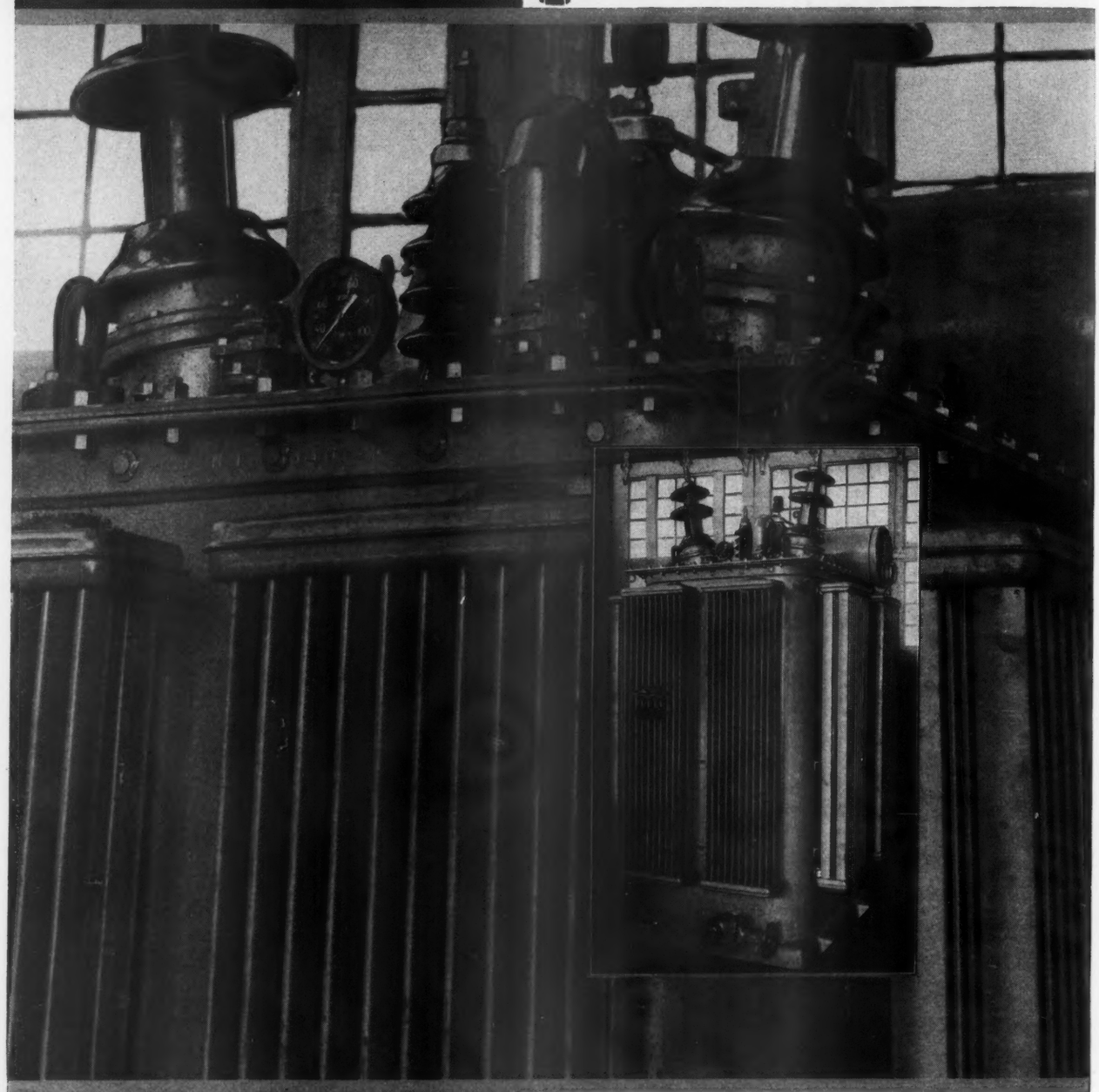

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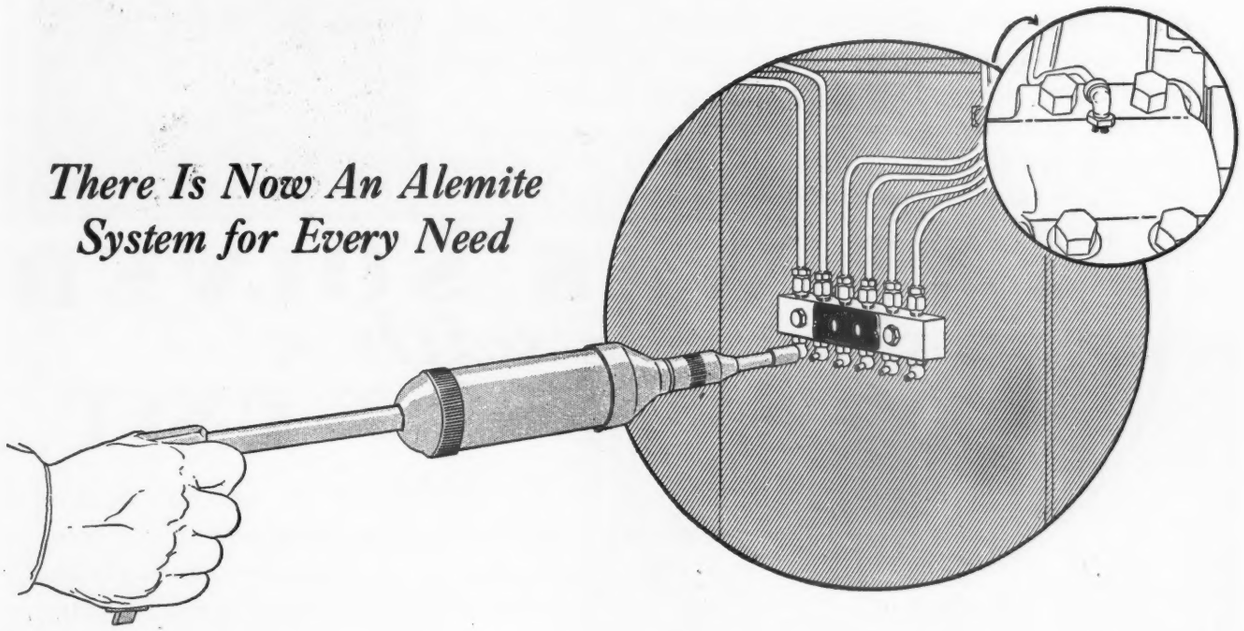
Industry Must No Longer Depend Upon the Uncertain Oil-Hole or Grease Cup

There Is Now An Alemite System for Every Need



INDUSTRY too long has been forced to depend upon the uncertain, inefficient oil-hole and grease cup. As a method of lubrication it is as archaic as the old John Bull locomotive. And while industry has long recognized the need for lubrication that matched the modernness of present-day machinery—until now there was no answer.

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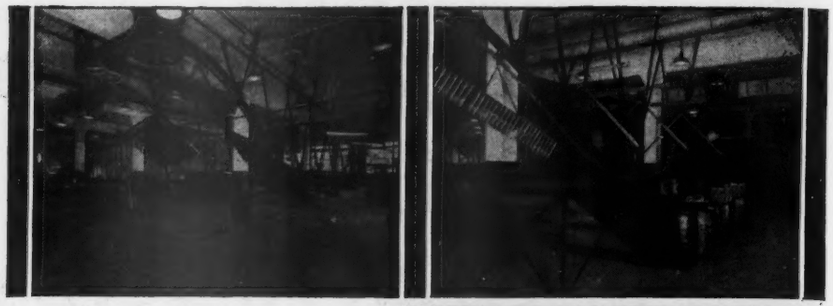

A large automobile equipment plant installed a 1400 ft. conveyor for windshield frames. It contained twenty-one right angle turns, eleven double dips and traveled through a series of paint tanks and drying ovens. To operate this conveyor economically at the desired speed of less than two feet per minute, presented a serious problem.

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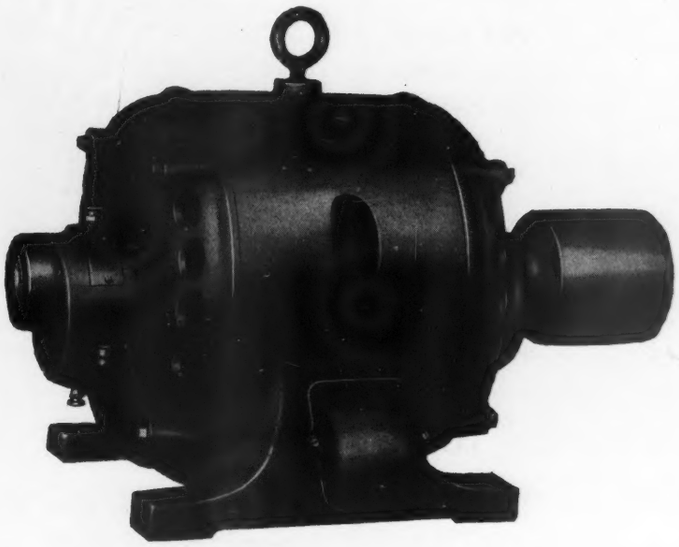

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Order one on 10 days' free trial.

6½-lb. Air Cooled Ball Bearing Motor $45.00 Net.

REDUCE your FIRE HAZARD and MOTOR TROUBLES by the frequent use of this "MARVEL" Portable Dust Blower, which gives a continuous blast of DRY air, for blowing inflammable dust out of your MOTORS and other machinery.

Ask us to ship you one on 10 DAYS' TRIAL.

Manufactured by

ELECTRIC BLOWER COMPANY

352 Atlantic Avenue, Boston 9, Mass., U. S. A.

O-Z Improved Hand Tachometers

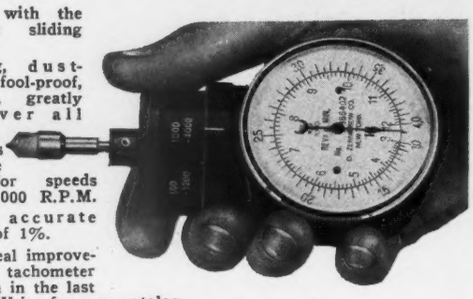
Do away with the troublesome sliding gear shift.

Ball-bearing, dust-proof, fool-proof, large dial, greatly reduced over all length.

Five ranges on one spindle, for speeds from 20-40,000 R.P.M.

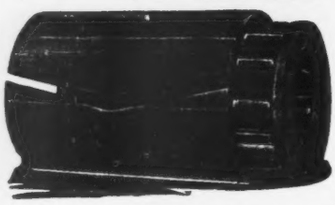
Dead-beat, accurate within ½ of 1%.

The only real improvement in tachometer construction in the last 20 years. Write for new catalog.



O. ZERNICKOW CO., 13 Park Row, New York City

A Smaller Bearing for a Heavier Load



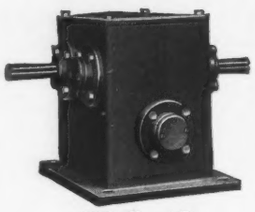
Rollers are machine tool steel—*solid*. This means greater load-carrying capacity.

All sizes carried in stock. **Liberal Discounts in Quantity.** Glad to tell you about this bearing.

Royersford Foundry & Machine Co.

Box E, Royersford, Penna.

2500 to 1!



WHS No. 4-D Reducing Gear

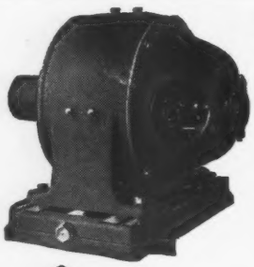
The new WHS No. 4-D Reducing Gear will give a ratio as large as 2,500 to 1. Send for special circular, also for catalog No. 23 showing a complete line of WHS Reducing Gears of small H. P. capacity.

WINFIELD H. SMITH, INC.

15 Eaton St. Springville, Erie Co., N. Y.

MARBLE-CARD MOTORS

D. C. and A. C.



Require only a minimum of servicing. Have unusually long life. Help maintain maximum production.

D. C. Machines up to 75 H.P. with commutating poles. Get Bulletin No. 200.

A.C. Machines up to 75 H.P. All standard speeds and voltages. Get Bulletin No. 300.

Built to a Standard

Marble-Card Electric Company

Gladstone, Michigan

WORCESTER BLEACH & DYE WORKS CO.

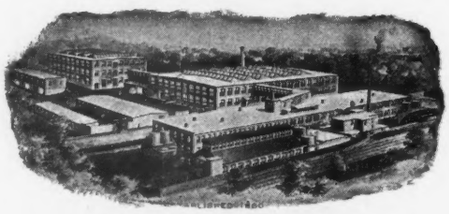
ESTABLISHED 1861

Bleachers, Dyers and Mercerizers of Cotton Yarns and Warps Winding on Cops, Tubes or Cones

Manufacturers of Cotton Yarns in Fast Colors

Glazed Cotton Yarns

"Sewing and Stitching Threads for All Industries"



Home of Silkslip Braider Thread

WORCESTER, MASS.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

A HEAVY DUTY PUSH BUTTON—

TYPE 6150 PUSH BUTTON

Oil-Immersed
Vapor-Proof
Moisture-Proof
and Dust-Tight—

Use either with or without oil.

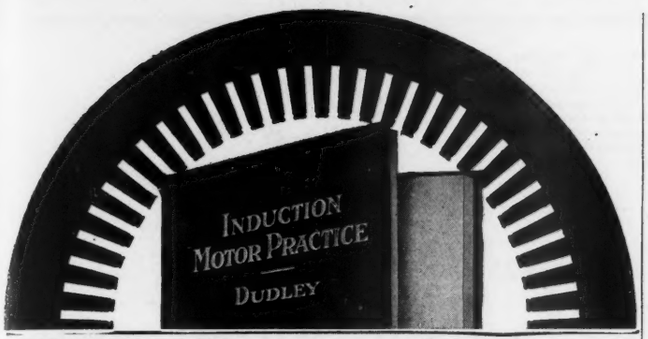
QUICK SERVICE

Commutators refilled with hard drawn copper to your specifications within a few hours after receipt of core and sample bars.

The Cleveland Armature Works, Inc.

4732 St. Clair Avenue

Cleveland, O.



FREE—if you order now?

TO EVERY MAN who subscribes to the **Library of Electrical Maintenance and Repair** NOW we will give you a copy of Dudleys' Induction Motor Practice, the latest and most practical book on the subject. No charge for it—it comes to you FREE with this helpful maintenance and repair library.

Electrical Maintenance and Repair

5 volumes—1810 pages—1756 pictures and diagrams

This library contains the largest collection of practical methods for electrical repair and maintenance men ever put together in book form. Here you will find the best modern practice in repair work. The authors have drawn not only from their own extensive experience, but from the experience of electrical maintenance men in large and small repair shops and manufacturing plants throughout the country.

Every maintenance and repair man needs them

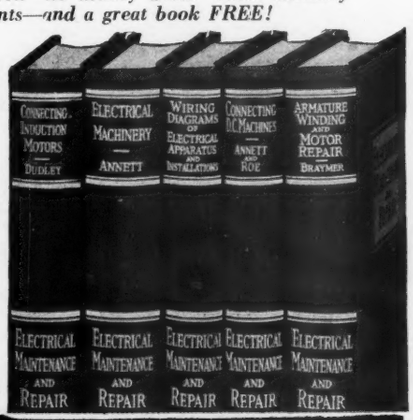
Every man concerned with the care and repair of electrical machinery should have these practical books. Every one of the five volumes is jammed to the covers with sound, how-to-do-it information—the kind you have to have when anything goes wrong.

The books contain hundreds of photographs, diagrams and tables, which show you how to go about it to make an effective repair job. There are wiring diagrams covering A.C. and D.C. generators, feeders, transformers, potential regulators, synchronous converters, batteries and boosters, substations, lamp mechanism connections, rheostats and controllers, lighting arresters, automobile switches, railway controllers, etc.

Free examination—no money down—small monthly payments—and a great book FREE!

Fill in and mail the coupon attached and we will send you the entire set of five volumes for ten days' Free Examination. We take all the risk—pay all charges.

You assume no obligation — you pay nothing unless you decide to keep the books. Then $1.00 in ten days and the balance at the rate of $2.00 a month. Upon receipt of your first payment we will send you a free copy of Dudley's Induction Motor Practice.


CONNECTING INDUCTION MOTORS — DUDLEY
ELECTRICAL MACHINERY — ARNETT
WIRING DIAGRAMS OF ELECTRICAL APPARATUS AND INSTALLATIONS
CONNECTING D.C. MACHINES — ARNETT AND ROE
ARMATURE WINDING AND MOTOR REPAIR — BRAYMER
ELECTRICAL MAINTENANCE AND REPAIR

FREE EXAMINATION COUPON

McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York.

Gentlemen:—Send me the **New Library of Electrical Maintenance and Repair,** all charges prepaid, for 10 days' Free Examination. If satisfactory I will send $1.00 in ten days and $2.00 a month until $15.00 has been paid. If not wanted I will return the books at your expense. Upon receipt of my first payment you are to send me a free copy of Dudley's Induction Motor Practice.
(IMPORTANT—Write plainly and *fill in all lines.*)

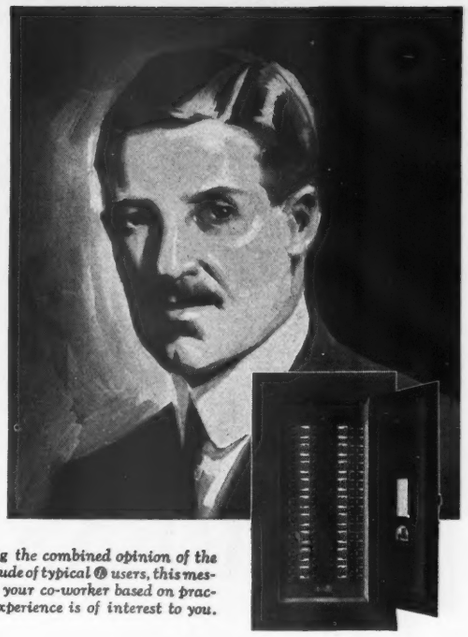
Name.....

Home Address.....

City and State.....

Name of Company.....

Occupation .....I.E. 12-29



Voicing the combined opinion of the multitude of typical Ⓕⓐ users, this message of your co-worker based on practical experience is of interest to you.

"I use Ⓕⓐ PANELBOARDS ...and I'll tell you why!"

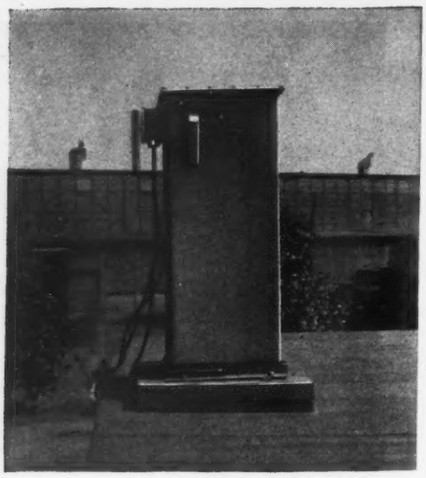
The four factors of panelboard selection are safety, troubleless operation, standardization and price. Because Ⓕⓐ Panelboards are sectionally built of black asbestos composition with live parts mounted on the back they are permanently safe. Because Ⓕⓐ Panelboards last as long as the building where they are installed and serve without maintenance they are troubleproof. Because both Ⓕⓐ Panelboards and Ⓕⓐ Steel cabinets are standardized with each other and separately in each part they are uniform always.

All these qualities interpreted in terms of price, in my opinion Ⓕⓐ Panelboards are lowest in cost. All in all, to know them is to use them.

Without obligation you are invited to use the Ⓕⓐ men in your nearest office for solving panelboard problems. Send for catalog No. 45—Free.

Frank Adam ELECTRIC COMPANY ST. LOUIS

Atlanta, Ga.	Detroit, Mich.	Omaha, Nebr.
Baltimore, Md.	Jacksonville, Fla.	Philadelphia, Pa.
Boston, Mass.	Kansas City, Mo.	Pittsburgh, Pa.
Buffalo, N. Y.	Los Angeles, Calif.	San Francisco, Calif.
Chicago, Ill.	Memphis, Tenn.	Seattle, Wash.
Cincinnati, Ohio	Minneapolis, Minn.	Tulsa, Okla.
Dallas, Texas	New Orleans, La.	Vancouver, B. C.
Denver, Colo.	New York, N. Y.	Winnipeg, Man.



60 kva., 220 volt E-M Capacitor mounted on roof of Thin Sheet Metals Co., Waterbury, Conn. Electric current is purchased. Capacitor raised power factor from 55 to guaranteed 70 or better and supplied better voltage regulation.

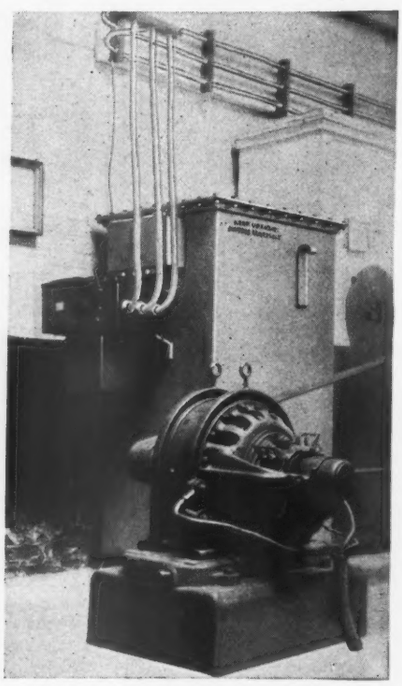
In Many Plants, Improved Power Factor Also Brings

INCREASED PRODUCTION

MOST manufacturing plants know the importance of high power factor. The savings in power bills made by power factor correction with E-M Capacitors are so tangible and so worthwhile that no plant will knowingly pass them by, and hence hundreds of plants have installed E-M Capacitors.

But there are also many, many plants in districts where power companies do not allow lower rates for good power factor loads, who find E-M Capacitors splendid investments, too . . . because they use E-M Capacitors *to increase production.*

How do they do it? Poor power factor tends to decrease voltage. "Poor voltage regulation," engineers call it. This low voltage makes motors run slower.



90 kv-a., 220 volt E-M Capacitor at Mount Clemens Pottery Co., Mount Clemens, Mich., increases power factor from 68 to guaranteed 90 or more and brings about a saving of from 4 to 5 per cent on the total power bill. Plant voltage is substantially raised, with a beneficial effect upon production.

So they install an E-M Capacitor. Up goes the voltage to normal. Motors drive machines and conveyors at their rated speeds.

If an E-M Capacitor can increase your daily output only 1% . . . how much is it worth to you? It probably won't cost nearly that much.

A competent engineer from the nearest of our 40 branch offices will be glad to call and discuss your specific problems with you in detail.

Electric Machinery Mfg. Company

Specialists in Apparatus for Power Factor Improvement

1335 Tyler Street, N. E. Minneapolis, Minn.

Sales Offices in Principal Cities

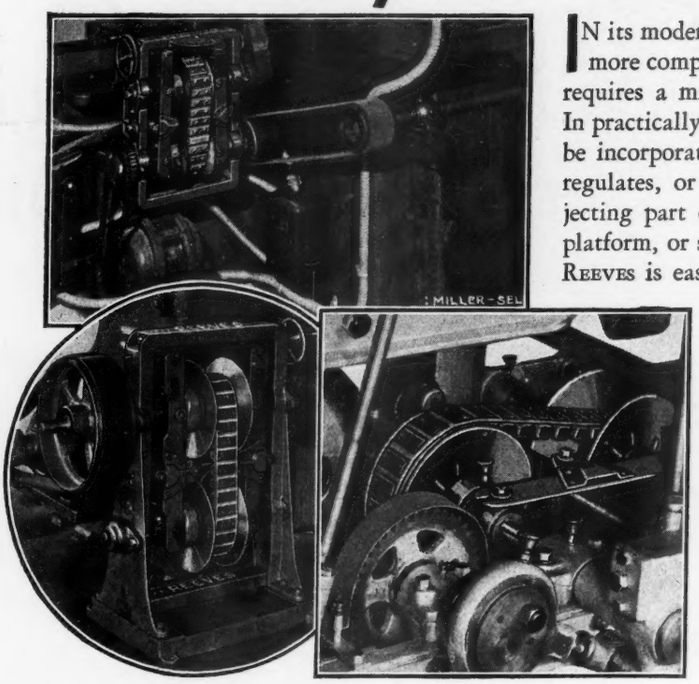
Users of E-M Equipment are assured of quick, reliable service by a corps of trained engineers working out of E-M offices in 40 cities. The specialized, quick-moving E-M factory and sales organization is always ready to give you prompt, skilled attention.

E-M *Power Factor Improvement* CAPACITORS

STATIC CONDENSERS FOR IMPROVING PLANT ELECTRICAL CONDITIONS

(1038)

COMPACT
in every installation

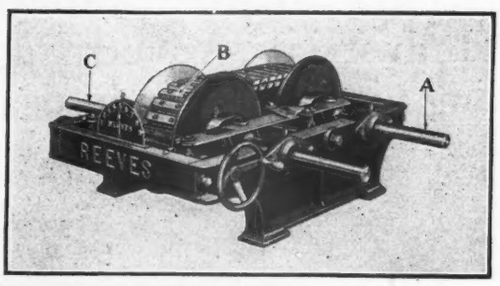


IN its modern design . . . shorter, narrower, more compact . . . the REEVES Transmission requires a minimum amount of floor space. In practically every installation, it can either be incorporated as a part of the machine it regulates, or it can be placed under a projecting part of the machine, mounted on a platform, or suspended from the ceiling. The REEVES is easy to install and takes up very little additional space beyond that already required by the machine it drives.

Above left: Showing the REEVES Transmission compactly mounted right on the frame of a Norton Grinder. *In circle:* Vertical type of REEVES closely installed at the driving end of a Swift Electric Welder. *Lower right:* Internal parts of REEVES built as a standard unit right into a Harton Cake Machine.

POSITIVE
in transmitting power

WITH the REEVES Transmission, any machine can be regulated instantly to run at any desired speed between predetermined limits of fast and slow. It will maintain any one set speed with *positive* accuracy . . . (A) shows the power input shaft which is driven at a constant speed . . . (B) shows the V-belt which *cannot slip* in the V-shaped throat formed by the cone-faced discs . . . (C) shows the power output shaft which remains constant at any one set speed, but which can be regulated, at the will of the operator, to any desired speed.



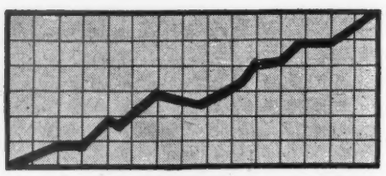
REEVES
Variable Speed Transmission

REEVES PULLEY COMPANY, *Columbus, Indiana*
Send your new catalog, E-88, and specific information about the_____(industry).
*Name*_____ *Company*_____ *Address*_____

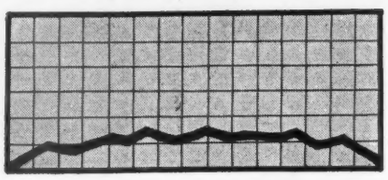
This is one of a series of advertisements directed originally to advertising men in an effort to make industrial advertising more profitable to buyer and seller. It is printed in these pages as an indication to readers that McGraw-Hill publishing standards mean advertising effectiveness as well as editorial virility.

What is wrong with this star salesman?

With the BBK Crane Company he was a phenomenal success.



He went with the XYZ Crane Corporation and was a dismal failure.



The difference is not in the salesman nor in the product but in the nature of the Industrial Advertising backing him. Every industrial salesman cannot be a star, but the best that is in him can be developed if the advertising policy and plan are based on achieving Recognition.

HOW TO build this recognition in ten simple steps is graphically explained in the book, "Industrial Marketing at Work." A copy will be delivered by the nearest McGraw-Hill office to any executive responsible for sales or advertising to industry.

McGRAW-HILL PUBLICATIONS

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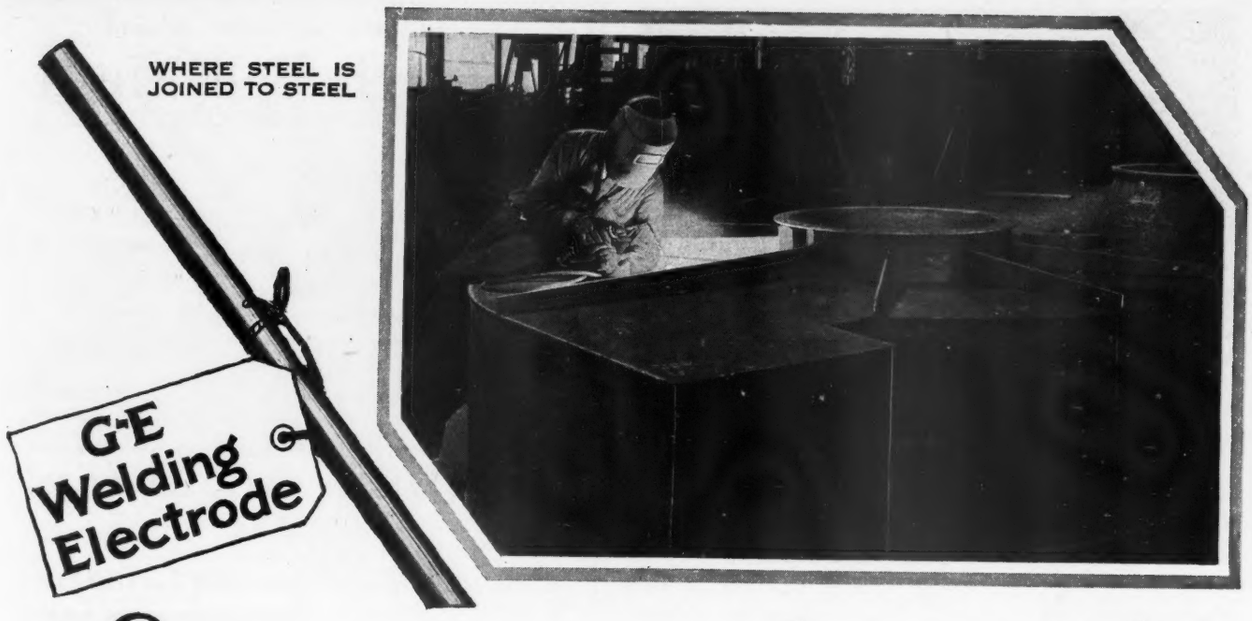
F-13



-*for* neat beads

Welders of exhaust-fan housings and siphon headers favor G-E Type "F" electrode because of its good penetration, rapid deposition, and arc stability.

There are other advantages which add to the natural preference of operators who have used Type "F". It can be easily manipulated and applied in any position. Header welds must be of high tensile strength and absolutely pressure-tight. Much of this work is a finish operation, requiring a non-spattering electrode and, above all, neat beads. Only an electrode of unusual excellence combines such qualities.

For prompt service or additional information as to various types of G-E electrodes, get in touch with the G-E Welding Electrode Distributor near you or write to Section E-4812, Merchandise Department, General Electric Company, Bridgeport, Connecticut.

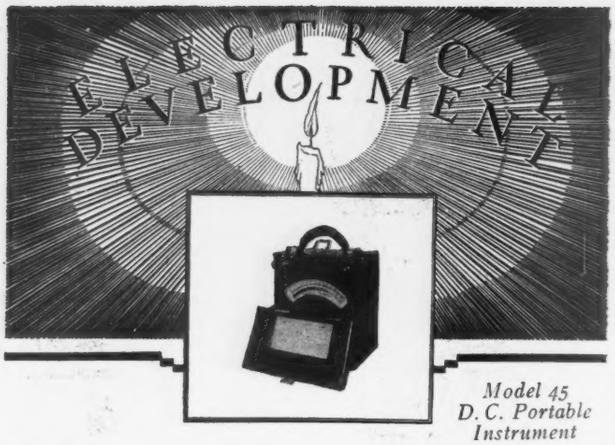
For simplicity, reliability, and ease of operation, G-E arc-welding sets are unequalled. They are available in all sizes, all types—for either hand or automatic operation—for one or more operators.

550-512

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

MERCHANDISE DEPARTMENT, BRIDGEPORT, CONNECTICUT



Model 45
D. C. Portable
Instrument

Can we throw some light on *your* problems?

NO single swallow makes a summer—nor does a single instrument go farther than a candle's feeble glow to lighten the problems of Electrical Development.

Take any Weston Instrument—any model or range. The most complete description possible would fail to convey a full conception of its probable uses. The needs of electrical measurement are too numerous and varied for even an attempt at classification with respect to the application of a single instrument or, for that matter, Weston's complete line of instruments.

It is a case where the mountain should come to Mohammed! For more than forty years the Electrical Industry has come to Weston for the solution of its measurement problems. With the tremendous increase in scientific developments, involving the use of new instruments and special requirements as to design, electrical characteristics and ranges, it is becoming a problem in itself to sense the exact needs in all branches of industry.

But Weston research, manufacturing and consultation facilities are available to all. Engineering and sales representation in all the principal cities of the world affords convenient points of contact with instrument headquarters, so that your problems *can be brought to us* for study and solution. If the abridged listing in our catalog does not cover the instruments you require, we shall be glad to receive your communication and will give it prompt attention.

Weston
PIONEERS SINCE 1888
INSTRUMENTS

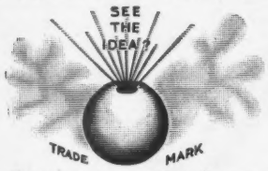
WESTON ELECTRICAL INSTRUMENT CORP.
597 Frelinghuysen Avenue Newark, N. J.

Babbitt Users - who know - demand

Monarch Ball Metal

The STEEL PROCESS BABBITT

FOR HIGH SPEED AND SEVERE SERVICE



If your Distributor cannot supply you, tell us.

MONARCH METAL COMPANY
Established 1895
119 South Lincoln Street CHICAGO

99.999% Accuracy!

IDEAL

Commutator Precision Grinders

For mounting on round or flat brush arms or bearing supports.

Turning badly scored commutators on lathe is no longer necessary.

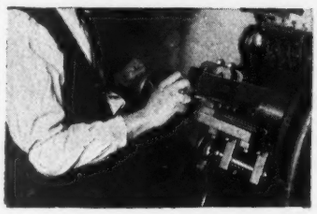
Save time and lengthy shutdowns by using Ideal Grinders. Accuracy to 1/1000 of an inch is common practice with Ideal Precision Grinders.

—because

Commutators are trued in their own bearings at own speed

Sent on 10-Day Trial

Complete Catalog Sent on Request



IDEAL COMMUTATOR DRESSER COMPANY
1065 Park Ave., Sycamore, Illinois 1229

Specify Instruments and Circuit Breakers by

ROLLER-SMITH COMPANY
Electrical Measuring and Protective Apparatus

MAIN OFFICE
229 Broadway, NEW YORK

WORKS
Bethlehem, Penna.

Offices in Principal Cities in U. S. A. and Canada
Representatives in Australia, Cuba, Philippine Islands and Japan

A-C-E

Coil making machines offer the latest in modern equipment for coil making.

Our machines are the simplest and less expensive and are being used by thousands of concerns throughout the world.

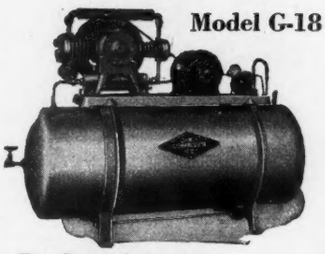
Our trial offer will prove the above facts.

Complete information on request

ARMATURE COIL EQUIPMENT CO.
MANUFACTURERS
2415 Forestdale Ave. Cleveland, Ohio

A Quincy for Economy!

Model G-18



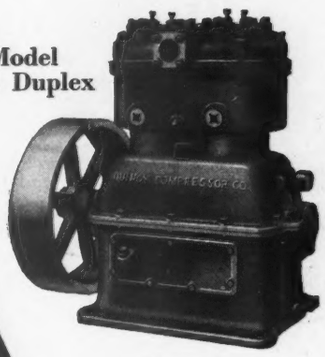
Two-Stage Automatic Unit, ¾ H. P. Motor. Tank, 20x48—65 Gal. 175-lb. cut-out pressure. 3¾ cu. ft. displacement. 1 H. P. for 4½ cu. ft. or 1½ H. P. for 6 cu. ft. 25 ft. hose with chuck. V-Belt of special rubber and fabric construction. Has unusual wearing qualities and minimum stretch.

This high quality line of water- and air-cooled air compressors is designed and built for the greatest economy in operation and up-keep—not to meet competing prices.

The Quincy line includes compressors without tanks and complete automatic units, with displacements of from 1 to 128 cubic feet per minute and requiring motors of from 1-4 H. P. to 25 H. P. All belt drives are equipped with highly efficient and quiet V-Belts.

Before ordering any compressor for operating pneumatic tools, pumping liquids, paint spraying or for fire protection equipment, write for complete details about the economical Quincy.

Model W-4 Duplex



Maximum Displacement 128 cu. ft. Maximum Pressure 150 lbs. Motor H. P. requirements, 15 to 25 H. P. Industrial uses, pneumatic tools, heavy duty requirements. Lubrication, force feed to all bearings. Suitable for direct connecting to gas engine or motor or short center multiple V-Belt drives.

QUINCY COMPRESSOR CO.

212 Maine St. Quincy, Ill.

Service and Sales Offices:

Atlanta, Ga. Birmingham, Ala. Buffalo, N. Y. Chicago, Ill. Cincinnati, O. Cleveland, O. Dallas, Tex. Detroit, Mich. Houston, Tex. Kansas City, Mo. Memphis, Tenn. Moline, Ill. New Orleans, La. Newark, N. J. St. Louis, Mo. Washington, D. C.

Also in other important centers

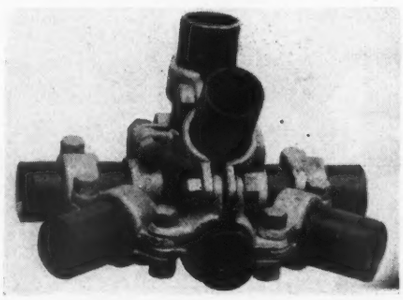
N18

UNICLAMP

These new clamp assemblies will unfold into strings in one plane when laid out.

Your storeroom investment, storage space, lost time and layout costs will be reduced.

Something new



PIPE FITTINGS

Uniclamps are forged from mild steel and hot galvanized by electric heat.

We have a 36 page bulletin with pictures, tables, charts and up-to-date engineering data. Ask for Bulletin No. 70.

A Real Advance

Please Address Industrial Division

Delta-Star Electric Co

2400 Block, Fulton St., Chicago, Ill.

Let Earle cut your Gears and cut your costs

EARLE GEARS

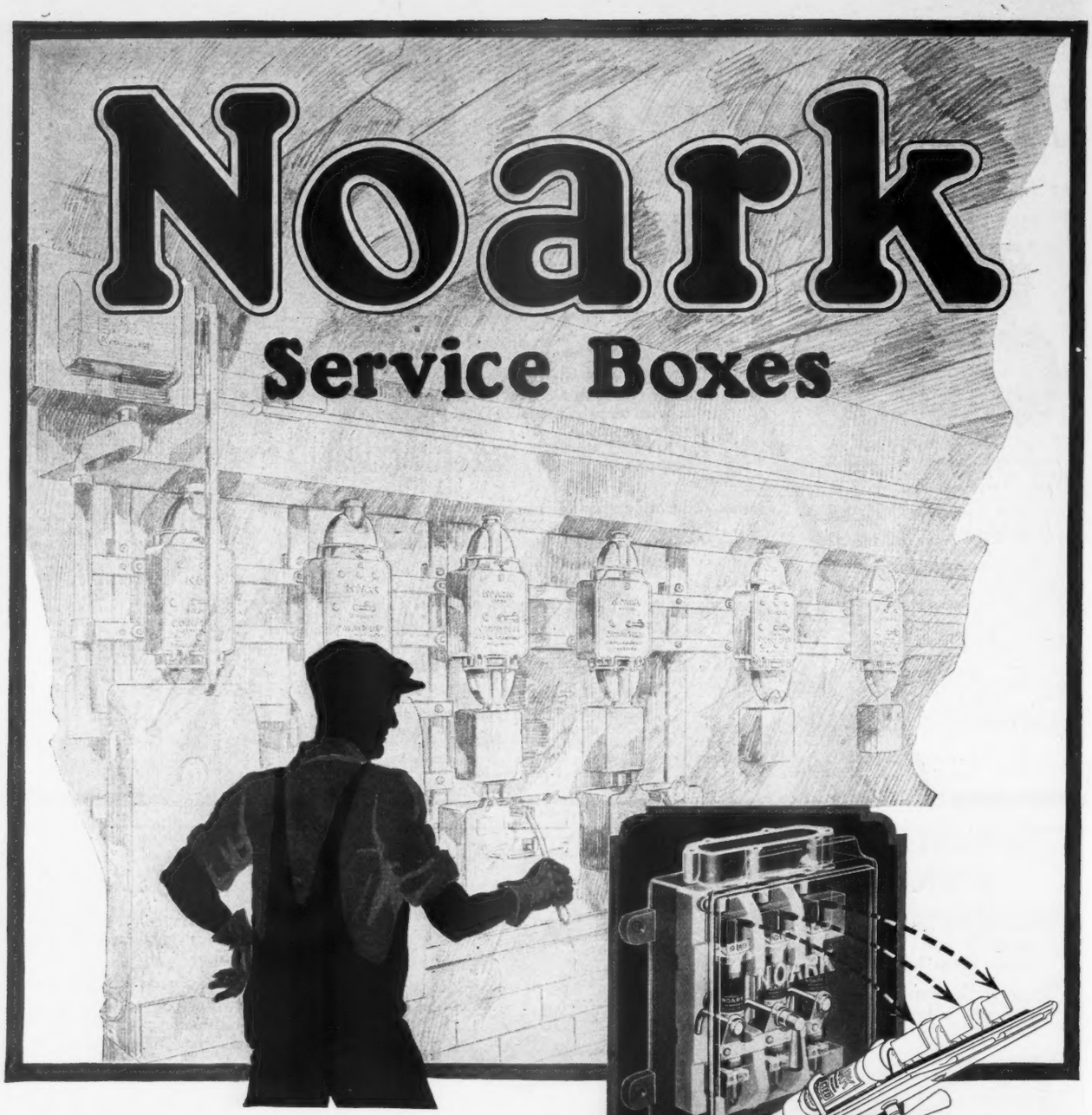
40,000 patterns from which almost any size and type of gear can be made, twenty-five years of experience, a modern plant equipped with machine tools of latest design, and skilled engineers and mechanics enable us to cut your costs by recommending gears to fit your conditions.

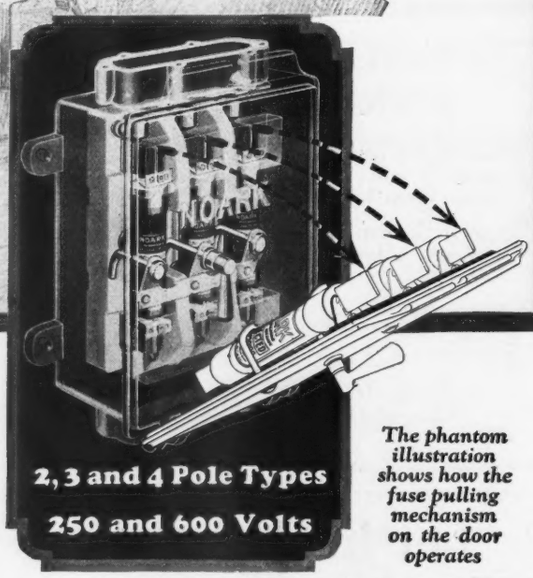
Every Earle Gear is made to your order and *delivered* when promised. Try Earle Service on your next RUSH order.

THE EARLE GEAR AND MACHINE CO.
4725 Stenton Avenue
PHILADELPHIA, PENNSYLVANIA
Operating Machinery, "Lea-Simplex" Cold Metal Saws

Noark

Service Boxes





2, 3 and 4 Pole Types

250 and 600 Volts

The phantom illustration shows how the fuse pulling mechanism on the door operates

They're there — every way!

At first, the heavy cast iron construction of NOARK Service Boxes made its strongest appeal to those who were faced with the problem of providing weather-proof cutouts for the control of electrical circuits — outdoors, on poles, building walls, construction machinery, etc.

But, just as soon as engineers were convinced that the cast iron housings and heavily gasketed doors of NOARK Service Boxes were quite as effective against acids, fumes and gases as against dampness, they began to specify these boxes for chemical plants, paper mills, galvanizing shops, dye works, packing houses and other industries where such destructive agencies are prevalent.

To place fuses in circuit: Insert fuses in the aligning clips on inside of cover; turn lever to horizontal position and close door.

To open circuit: Turn handle to horizontal position and open door.

To inspect fuses without opening circuit: Turn handle to vertical position and open door.

COMING! The most revolutionary advance in industrial switch design is soon to make its appearance. Watch for announcement by Colt

COLT'S PATENT FIRE ARMS MFG. CO.
ELECTRICAL DIVISION
HARTFORD, CONNECTICUT, U. S. A.
NEW YORK • BOSTON • PHILADELPHIA • CHICAGO • SAN FRANCISCO

33-W-46

Westinghouse-Nuttall single reduction gear unit with 7 to 1 ratio transmitting 450 hp. at 700 rpm. on a rod mill drive.

Efficient Mill Drives

EFFICIENCY cannot be overlooked when considering gear drives for mill service, particularly when the horsepower to be transmitted reaches into the high hundreds or even to thousands. For it is then that the slightest improvement in the efficiency of the transmission unit resolves into appreciable savings in the annual power requirements.

The performance on a no-load test of a Westinghouse-Nuttall single reduction unit having helical gears and Timken roller bearings, gave evidence of the friction-free condition that exists in these units. Brought up to its rated speed of 700 rpm., the unit ran for 28 minutes after the driving motor had been cut off, before coming to a stop.

This exceptional ease of operation means that the starting torque is surprisingly low and that the power transmission losses are reduced to the minimum. In design and construction, a considerable reduction in the size, and consequently, in the weight, of these heavy duty units marks another significant improvement.

These are important reasons why it pays to drive through Westinghouse-Nuttall mill units.

Competent engineers are available for studying your requirements. Call or write the nearest Westinghouse sales office.

WESTINGHOUSE ELECTRIC & MFG. COMPANY
NUTTALL WORKS PITTSBURGH, PENNSYLVANIA
SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES
CANADIAN AGENTS: LYMAN TUBE & SUPPLY COMPANY

Westinghouse

T 30804

Industrial Products include:

Arc-welding equipment	Capacitor	Insulating Materials	Micarta Gears	Speed Reducers
Automatic Switching	Circuit-breakers	Lighting Equipment	Motors and Control	Stokers
Babbitt and Babbitt Pots	Electric Ovens	Locomotives	Panelboards	Switchboards
Battery Chargers	Instruments and Meters	Mazda Lamps	Safety Switches	Transformers
				Turbines

"*Where* do we go from here?"

The spread and speed of American business have intensified the problem of plant expansion. Economic geography has become a new concern of industry.

"Where are our sources of raw materials? Is that the best place to go from a labor angle? Would we be too far from our markets? What are the power and transportation facilities? Will local legislation affect our costs? *Where* do we go from here?"

Every growing concern has wrestled with these problems. They have been compelled to contact many sources of information. They have had to scrape off the veneer of local enthusiasm to get at the real facts. Many have wondered why there was no clearing house for such data—no reliable source to turn to for confidential, unbiased help.

With the recent establishment of an Industrial Site Service Bureau, McGraw-Hill seeks to provide this long-needed service. It does so with the feeling that it will be of very practical help to its readers.

We invite you to use the Industrial Site Service Bureau in making your preliminary studies of new locations. You can do so with complete assurance that your interests will be guarded with strict confidence. Are you seeking a new location? Do you desire to buy or lease a vacant plant or do you wish to build? What factors chiefly affect your selection of a new location? Maybe you've not even considered it. Should you?

Address your inquiries to Industrial Site Service Bureau, McGraw-Hill Publishing Company, Inc., Tenth Avenue at 36th Street, New York.

INDUSTRIAL SITE SERVICE BUREAU

Mc GRAW · HILL · PUBLICATIONS

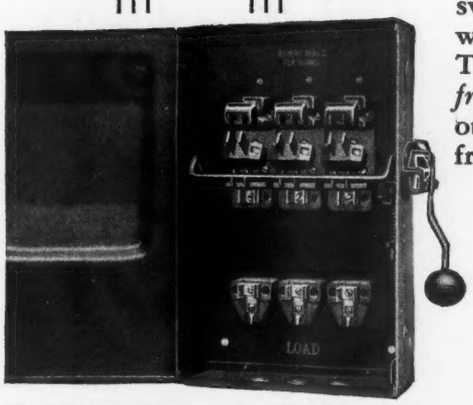
IS-2

why accept less... than all you can get?

WHEN you buy a safety switch, you pay for practical advantages. The C-H "Mill Duty" Current Breaker offers all the following advantages—and it is unnecessary to accept a switch which does not measure up to the Current Breaker in every way:

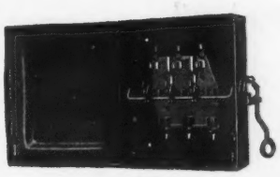
1. The double-break contactors and reduced air space minimize arcing . . . lengthen contact life tremendously.
2. Quick make and quick break . . . which further reduce arcing.
3. Flexibly mounted, self-aligning blades; a perfect contact always assured.
4. All parts removable from front without dismounting switch box.
5. No current carried by hinge parts, screws or bushings.
6. Positive operation even if spring should be broken accidentally.
7. Interlocked cover and mechanism . . . for safety; however, switch may be tested with cover open.

The C-H "Mill Duty" Current Breaker is the only safety switch with all these advantages. In addition, it is easy to wire, easy to mount—and in case of accident, easy to repair. The Current Breaker is built to give the maximum *trouble-free* service. Detailed information as to this safety switch and others in the Cutler-Hammer complete line may be obtained from your electrical supply jobber . . . or from us direct.



C-H "Mill Duty" Current Breaker (Bul. 4101)

CUTLER-HAMMER, Inc.
Trumbull-Vanderpoel Electric Mfg. Co., Subsidiary
1309 St. Paul Avenue
MILWAUKEE - - WISCONSIN



C-H Standard Duty (Type C) Safety Switch (Bulletin 4131)

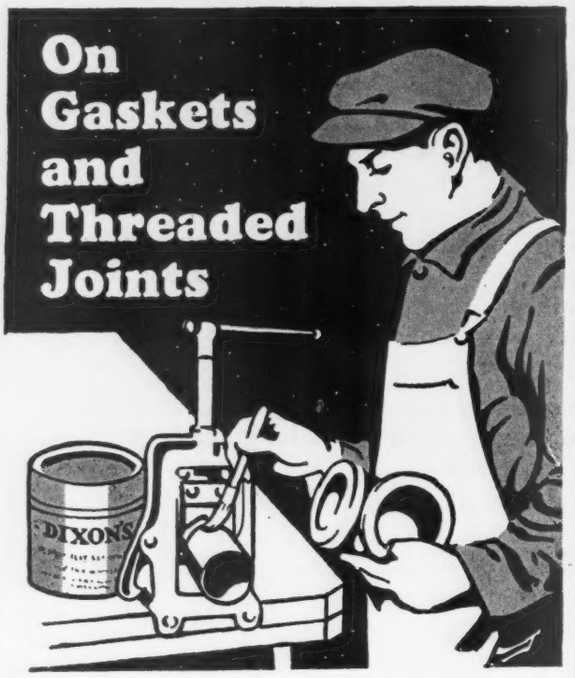
Type "C" construction plus—Quick make and quick break—molded, crack-proof base—rugged construction throughout—make this an ideal switch for general duty. It wears for years—maintains its efficiency—with unusually low upkeep costs. Made in 6 sizes from 30 to 400 amps. at 250 and 600 volts.

CUTLER HAMMER

High Quality Safety Switches For Every Service

(9617)

On Gaskets and Threaded Joints



For Oil, Gasoline, High-Pressure Steam, Vacuum, Gas, and any other Non-Aqueous Service

. . . . *Dixon's Graphite Seal* makes all types of joints permanently tight and absolutely leak proof. Insoluble in oil or gasoline; and resists the most intense heat; expanding slightly and permanently, thus making the joint absolutely leak proof. Soluble in warm water so that gaskets can easily be removed without injury. Thinned with water, and cannot flavor or discolor solutions conveyed.

DIXON'S GRAPHITE SEAL

For Hot or Cold Water, Air, Vacuum, and High or Low Pressure Steam

. . . . *Dixon's-Pipe Joint Compound* makes absolutely tight joints but does not harden or set. This permits joints to be opened easily at any time—saves labor, fitting and tools. One pound is equal to about four pounds of red or white lead and is therefore less expensive.

DIXON'S PIPE-JOINT Compound

Write for Bulletin 48-DS which gives full information regarding these two modern aids to efficient operation.

JOSEPH DIXON CRUCIBLE COMPANY

JERSEY CITY D X N TRADE MARK N. J., U. S. A.

Established 1827

DIXON'S GRAPHITE PRODUCTS

Flake Graphite
Graphite Cup Grease
Waterproof Graphite Grease
Solid Belt Dressing
Paste Belt Dressing
Silica-Graphite Paint
Boiler Graphite
Pipe Joint Compound
Graphite Spring Oil
Dixon's Graphite Seal

BALL BEARING **Clements** PORTABLE ELECTRIC

Cadillac BLOWER

Three Useful Handy Machines in ONE!

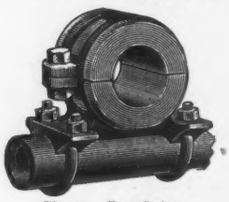
BLOWER
SUCTION CLEANER
SPRAYER

10 days FREE TRIAL
Write for Details

CLEMENTS MFG. CO.
617 Fulton St., Chicago, Ill.

Oldest and Largest Manufacturers of Portable Electric Blowers.

FLETCHER SPECIALTIES



Clamp Insulator Supports

For Flat Mounting

Catalog for our full line on application

FLETCHER MFG. CO.
Dayton, Ohio

If you are in charge of employment and need good men—

Or you are an individual seeking a better position—

ADVERTISE *in the employment columns of the* SEARCHLIGHT SECTION

SOLENOID MAGNET VALVES

PACKLESS TYPE

FOR AUTOMATIC—REMOTE CONTROL

No Packing—No Leaks
No Maintenance

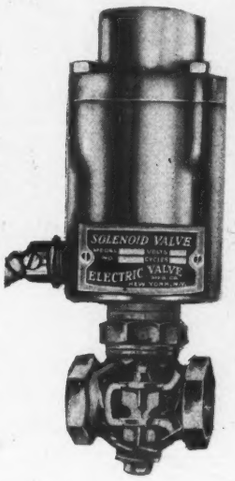
Magnetically operated Valves for automatic or remote control of water, oil, gas, steam, oil, etc.

Actuated for remote control by push button or automatically by 2-wire thermostat, time switch, pressure regulator, etc.

Operated direct from lighting circuit.

Used extensively for automatic temperature control.

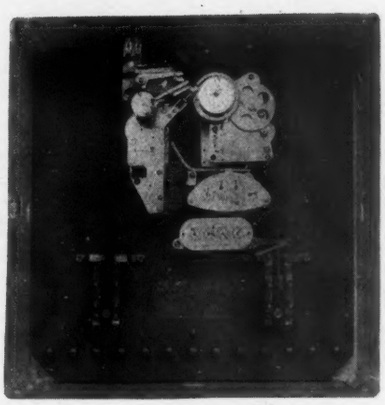
Furnished in all voltages up to 250 D. C.-440 A. C.



ELECTRIC VALVE MFG. CO.
68 Murray Street, New York, N. Y.

The
POWER DEMAND LIMUTER

REDUCES



DEMANDS

Eliminates the excessive and unnecessary peaks of the electric power demand automatically.

SIMPLE - RELIABLE

Write for Descriptive Bulletin

Manufactured By
STEELCITY FURNACE COMPANY
P. O. Box 1008 Pittsburgh, Pa.

IN *ONE* INSTRUMENT

A complete Resistance testing Unit

"BRIDGE-MEG"
RESISTANCE TESTER

THIS compact, sturdy instrument provides, for the first time in one self-contained unit, a ready means for quick, accurate tests of resistance over the entire range of practical requirements—from 1/100 ohm up to 100,000,000 ohms (100 megohms).

Every time you need to test resistance you can use this new "MEGGER" instrument. If it is conductor resistance of coils, windings, relays or rheostats, simply connect the two terminals, set the change-over dial to "Bridge" and, while turning the crank, adjust the Wheatstone Bridge dials till the ohmmeter pointer shows a balance. Read result directly from the dial positions.

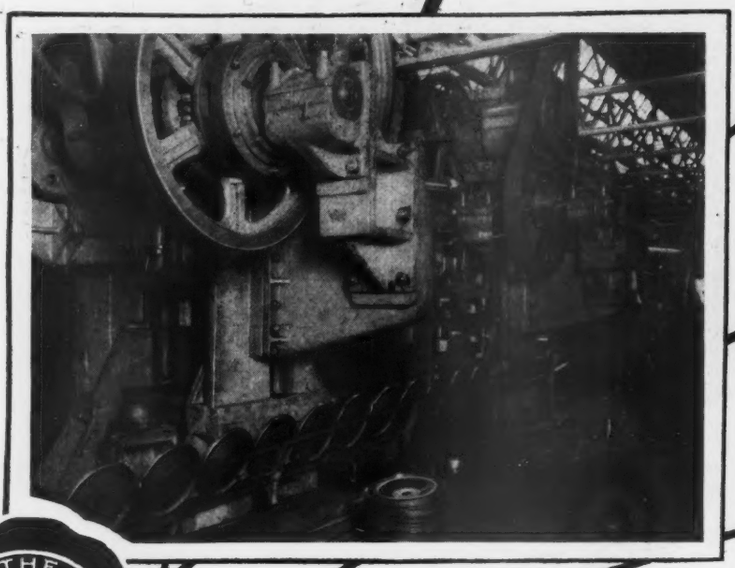
For insulation resistance tests of motors, generators, cables, wiring—in fact *all types* of electrical apparatus—the hand generator develops 500 volts d.c. Set the change-over dial to "Meg", turn the crank till the clutch slips—as with any of our constant-pressure "Megger" instruments, and read the scale directly in ohms and megohms.

The "Bridge-Meg" has only two binding posts, it weighs only 12¾ pounds, and is always ready for use. All of the inherent dependability and simplicity for which "Megger" instruments are famous, are built into the "Bridge-Meg."

Send for Bulletin 1255-K.

JAMES G. BIDDLE
ELECTRICAL INSTRUMENTS
1211-13 Arch St. Philadelphia

"3 results of superior lubrication"



Save Wear

Eliminate Breakdowns

Speed Production

THE PURE OIL CO

Think of the "PURE OIL" organization as men vitally interested in your own problems of maintenance and production. The interest of "PURE OIL" men goes far beyond just selling you lubricants.

There are special reasons why the Pure Oil Company can aid you in keeping all your machine equipment correctly lubricated. Pure Oil's knowledge and experience with lubricants starts at the production *source*, continues through all the processes of refining and distribution, and is augmented by hundreds of contacts with Industry.

The high quality of PURE OIL Lubricants has become traditional in Industry. High quality in the crude is combined with the "last word" in refining processes.

It is these factors that have made such oils as "Dark Puro Valve," "Red Clipper," "Dark Clipper," "650 Z Cylinder," "Allvis," "Sultur," "Nulube Turbine," the names that to industry are synonyms of "dependable lubrication."

'Phone, write, or wire to nearest office for Pure Oil service.

THE PURE OIL COMPANY

U. S. A.

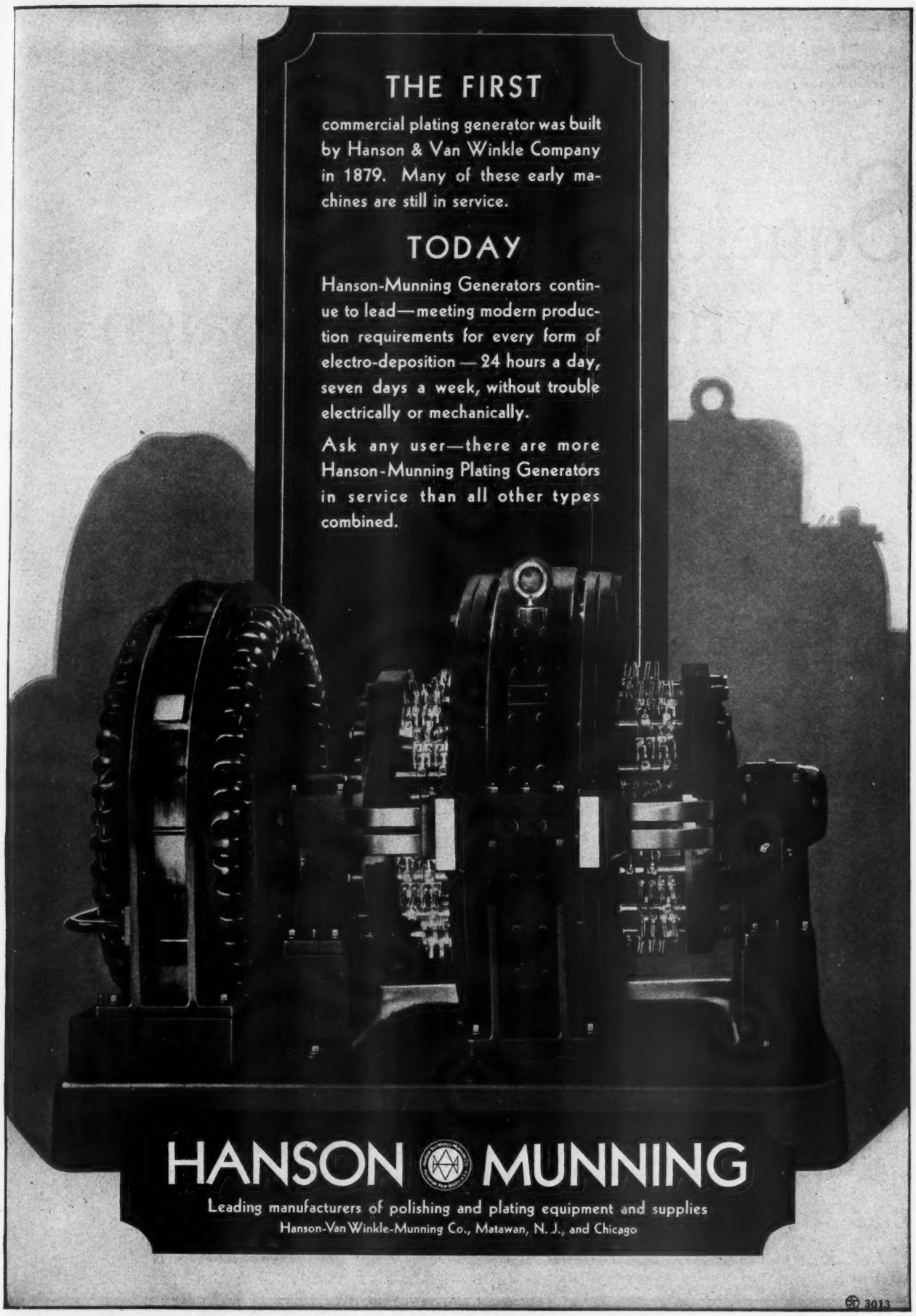
Producers, Refiners, Marketers of a complete line of petroleum products

REFINERIES:

Marcus Hook, Pa.
Cabin Creek Jct., W. Va.
Ardmore, Okla
Muskogee, Okla.
Heath, Ohio
Smith's Bluff, Texas

SALES OFFICES:

Chicago
Miami, Fla.
Atlanta, Ga.
Minneapolis
Tulsa, Okla.
Pittsburgh
Cincinnati, O.
Tampa, Fla
Norfolk, Va.
New York
Pensacola, Fla.
Philadelphia
Charleston, W. Va.
Columbus, O.
Beaumont, Texas


THE FIRST
commercial plating generator was built by Hanson & Van Winkle Company in 1879. Many of these early machines are still in service.
TODAY
Hanson-Munning Generators continue to lead—meeting modern production requirements for every form of electro-deposition — 24 hours a day, seven days a week, without trouble electrically or mechanically.
Ask any user—there are more Hanson-Munning Plating Generators in service than all other types combined.
HANSON MUNNING
Leading manufacturers of polishing and plating equipment and supplies
Hanson-Van Winkle-Munning Co., Matawan, N. J., and Chicago
3013

This is one of a series of advertisements directed originally to advertising men in an effort to make industrial advertising more profitable to buyer and seller. It is printed in these pages as an indication to readers that McGraw-Hill publishing standards mean advertising effectiveness as well as editorial virility.

Squelching another whispering campaign—

"Look out for that company, it's slipping," said the whisperers. Its product, an assembled unit sold to manufacturers to build into their machines, was of high quality but had been sold only through salesmen and direct mail.

Sales *were* falling off. The market, conscious of the gossip, was suspicious of the financial strength of the seller. This increasing sales resistance was undermining the morale of the sales staff.

With this serious situation facing it, the company called in an advertising agent who recommended an emergency advertising campaign in a McGraw-Hill publication covering the particular market. The program, the first publication advertising ever used by this company, consisted of color spreads in every issue.

That was only a year ago. Today, as evidence of the company's comeback, sales are not only mounting but the advertiser's chief competitor has offered to sell out to the new advertiser. *From bottom place to top position in recognition in one year.*

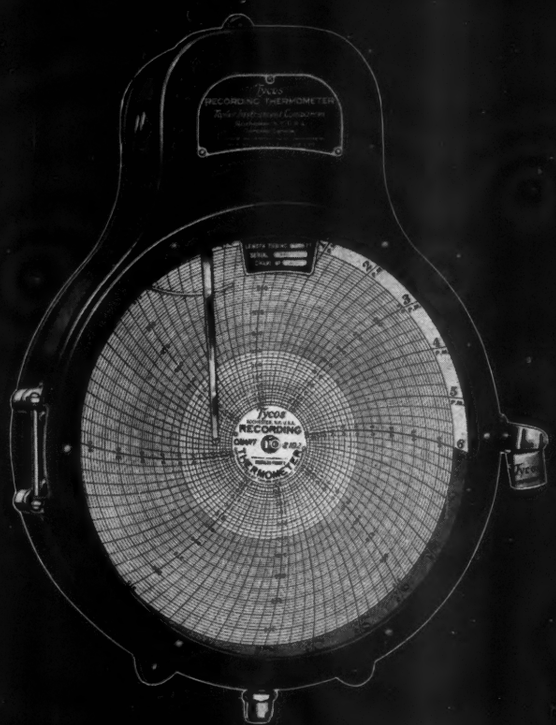
MORAL: Selling is not a choice between salesmen, publication advertising and direct mail but a matter of co-ordinating all three and using each on a basis of the job to be done.

McGRAW-HILL PUBLICATIONS

New York Chicago Cleveland Detroit Philadelphia St. Louis
Greenville San Francisco Boston London

P-12

Tycos



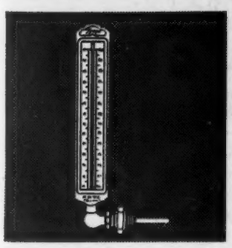
—temperature right . . . danger *past!*

Temperatures of bearings; temperatures of motor windings; temperatures of steam; and of furnaces and water and scores of other vital plant temperatures, rank among the most valuable indications of plant conditions—general and specific.

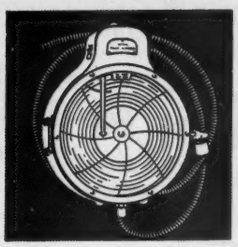
Not only in announcing danger but rather in preventing it with day by day pictures of temperatures. *Tycos* Instruments live up to the responsibility of the job. It is no mere chance that "*Tycos*" is synonymous with accuracy and stamina —all *Tycos* Instruments are *built* that way.

Indicating and Recording Thermometers and Pyrometers. Hygrometers. Temperature Regulators. Pressure Regulators.

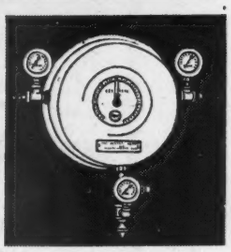
Specify "*Tycos.*"



INDICATING



RECORDING



CONTROLLING

Taylor Instrument Companies

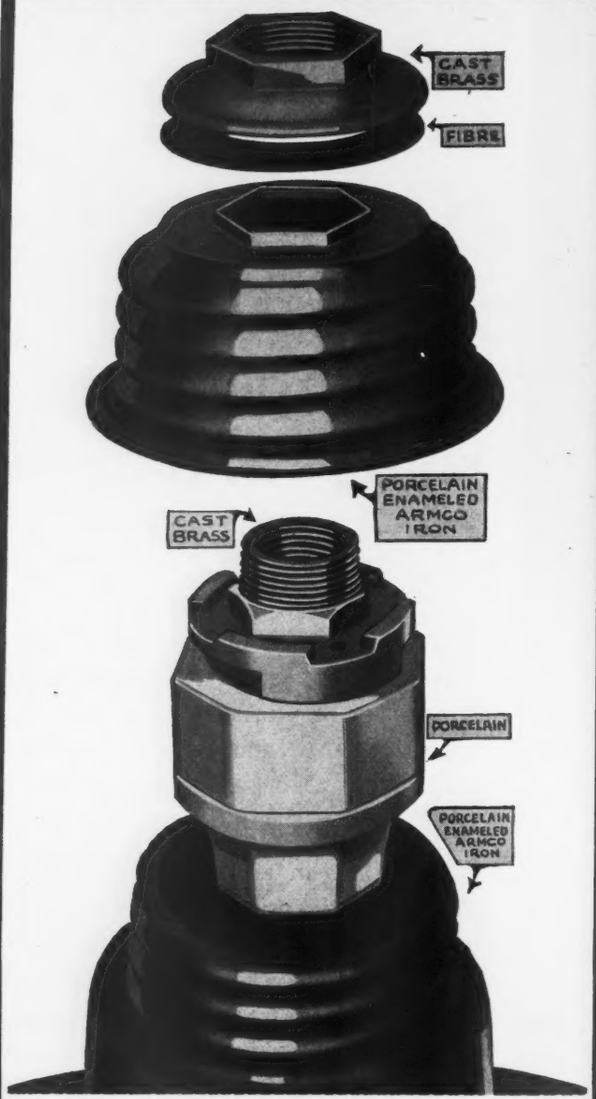
ROCHESTER, N. Y., U. S. A.

Canadian Plant, *Tycos* Building, Toronto, Canada

New York Chicago Boston Philadelphia Pittsburgh Cleveland Los Angeles Indianapolis San Francisco St. Louis Cincinnati Tulsa Detroit Atlanta Minneapolis

Manufacturing Distributors in Great Britain, Short & Mason Ltd., London

STRONG & RIGID



Designed and built to stay put—note the cast brass flange-nut conduit connection; also adapter and how these two heavy castings are threaded together to make the whole unit practically integral—The thoughts uppermost in the minds of the engineers in designing this holder were—

EASY WIRING, EASY CLEANING and STURDY SIMPLICITY

Catalog No. 180 will show you how this holder makes Abolite RLM Domes, Shallow Domes and Deep Bowl Reflectors— Interchangeable.

The ABolite Reflector Co.
2114 Terminal Tower Cleveland, Ohio

ABolite
DOME and BOWL
REFLECTORS

Don't Guess Use a Standco Speed Indicator

Machine Hour Costs are figured in R.P.M.

and a Standco Speed Indicator gives you a direct speed reading that is positively accurate.

Thus helping to keep equipment operating at best rated speeds and naturally the most profitable speeds.

Three distinct advantages of Standco Speed Indicators are: it is a revolution counter and surface speed indicator; a chronometer which times period of test; it completely eliminates personal equation.

Two ranges complete as shown, No. 2301, 0-30,000 R.P.M. and No. 2302, 0-1000 R.P.M. List Price $31.25. Write for complete details.

HERMAN H. STICHT & CO.
Electrical and Industrial Instruments
17 Park Row New York, N. Y.

An unusual night photograph of the railroad yard of a prominent eastern railroad floodlighted with Golden Glow projectors. Three towers are used, all similarly equipped with projectors. The one illustrated is equipped with seven 24-inch and ten 20-inch units.

FLOODLIGHTING
WITH
GOLDEN GLOW PROJECTORS

The new Golden Glow projectors of all aluminum construction which are fitted with the famous Golden Glow mirror glass reflectors and many other advantageous features of construction present a most efficient unit for railroad yard floodlighting and projects of similar nature about industrial plants. They are used extensively for building illumination because of their high efficiency and long lasting construction.

Our engineers are ready at all times to assist you with any illumination problems you may have. Call upon this service when you need it and send for catalog now.

ELECTRIC SERVICE SUPPLIES CO.

MANUFACTURER OF RAILWAY, POWER AND INDUSTRIAL ELECTRICAL MATERIAL

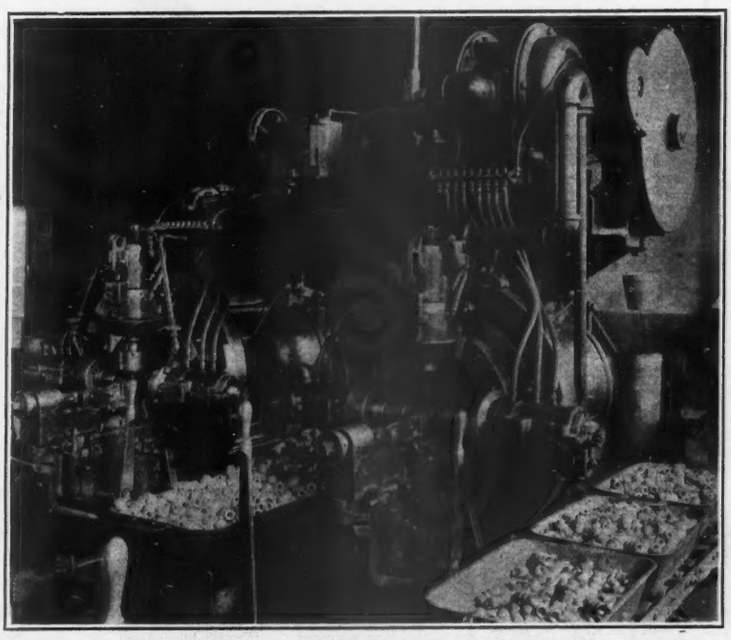
17th and Cambria Streets, Philadelphia, Pa.; 111 North Canal Street, Chicago, Ill.; 50 Church Street, New York City.

Branches — Pittsburgh, Boston, Detroit, Scranton, Canadian Agents—Lyman Tube & Supply Co., Ltd., Montreal, Toronto, Vancouver.

ARLNS
BLANCHARD PULSATING SYSTEM

PROVIDES AUTOMATIC OIL LUBRICATION
FOR ALL CLASSES OF MACHINERY

One of a battery of Blanchard-equipped Pottstown Tapping Machines at the Walworth Company, South Boston, Mass.



Note the flexible hose drip connections running from the gangs of feeders to the bearings of the tapping heads which permit swiveling the heads to any angle as the work in process may require. Each drip connection leads from an individually adjustable feeder in the gang. The oil pipe line which serves the gangs also serves numerous individual feeders directly located at bearing points. One powerful pulsating pump—one closed oil pipe line—any number of individually adjustable feeders.

BULLETINS B-1 and B-2
ARE FULLY DESCRIPTIVE

LUBRICATION DIVISION

Rivett Lathe and Grinder Corp.
Brighton Dist., Boston, Mass.

This is one of a series of advertisements directed originally to advertising men in an effort to make industrial advertising more profitable to buyer and seller. It is printed in these pages as an indication to readers that McGraw-Hill publishing standards mean advertising effectiveness as well as editorial virility.

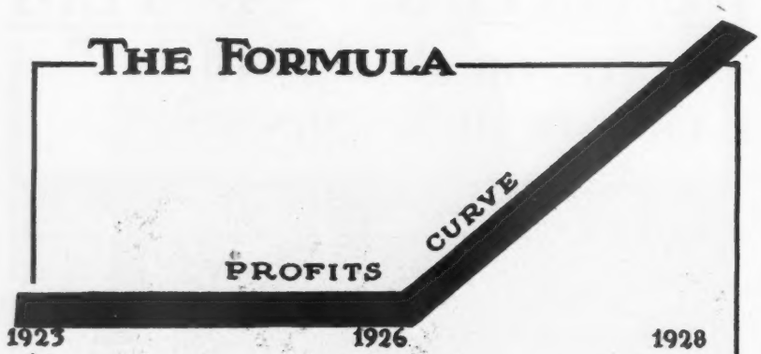
PATENTS EXPIRING!

what'll we do?
what'll <u>others</u> do?

BASIC patents on a machine used extensively by a specific industry were owned by the ABC Corp.

The XYZ Co. also made the machine, along with other products, paying the ABC people a royalty for every machine sold. The XYZ Co. chose to stay in business without making a practical profit on this particular product. *Why?*

Two years or so ago the patents expired. The expected happened. Dozens of manufacturers turned to making the machine. But instead of diminishing sales for the XYZ Co., there came increased sales, pyramiding profits and leadership in the field. This leadership is being maintained today by the same formula that was used steadily for three years before industry-at-large was free to make the machine.



During this three-year period, when XYZ's profits were barely enough to pay the patent owners, XYZ advertised regularly in McGraw-Hill Publications—building recognition for the future—intrenching themselves in a strategic position for the *post-patent period*.

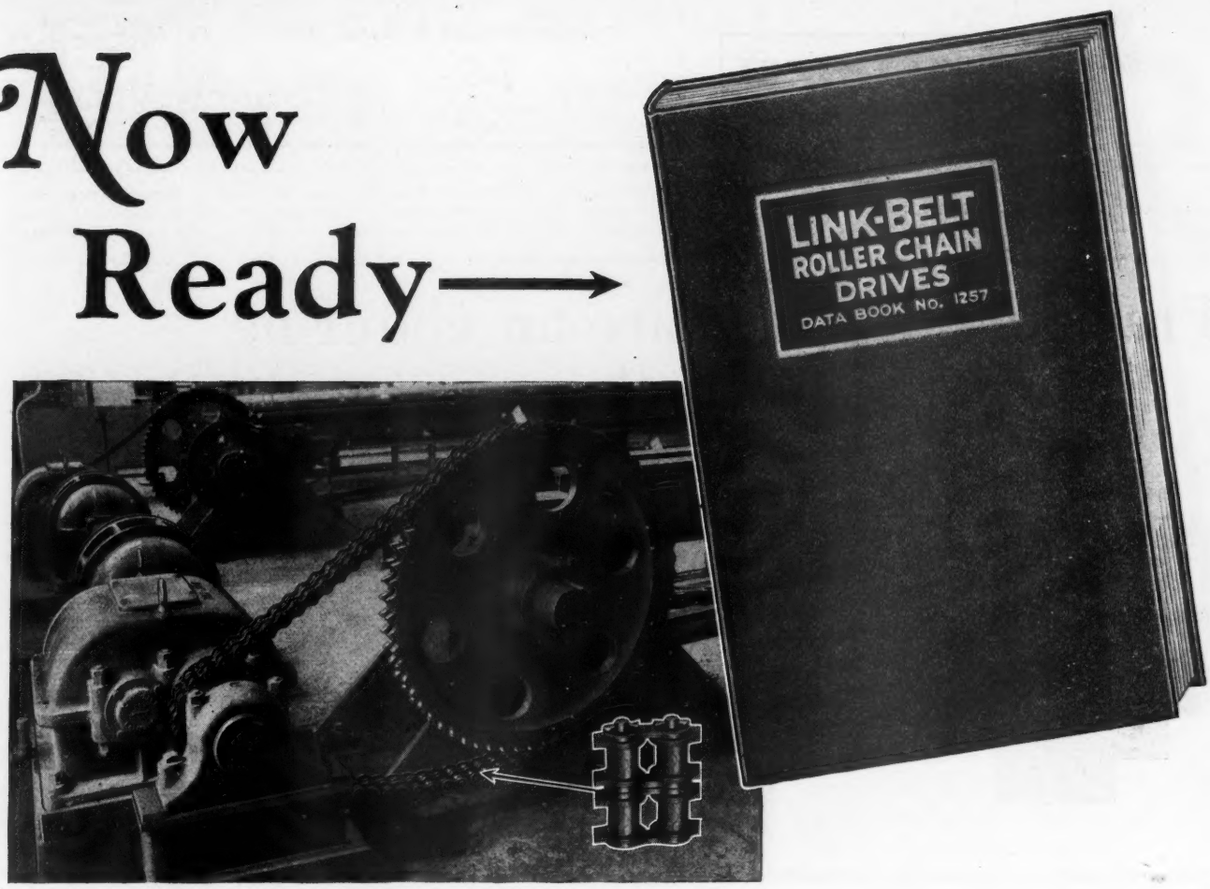
Pyramided effects of continous industrial advertising sent sales and profits constantly upward after patents expired. A sustained advertising program of full and double pages, with pithy, factful copy, is keeping the XYZ Co. in top place. A clear-cut victory—not so much for McGraw-Hill publications but for Industrial Advertising strategically applied.

McGRAW-HILL PUBLICATIONS

New York Chicago Cleveland Detroit Philadelphia St. Louis
Greenville San Francisco Boston London

F-15

Now Ready →



The New Link-Belt Roller Chain Drive Data Book 1257

Makes the selection of the correct roller chain drive a simple and easy matter. Complete with list prices, illustrations and instructions. The most comprehensive data book we have ever published on Roller Chain. 96 pages of valuable facts. Presents lists of wheels up to 81 teeth. All pitches of chain carried in stock.

RETURN COUPON FOR YOUR COPY

I. E.

LINK-BELT COMPANY
501 N. Holmes Ave.
Indianapolis, Indiana
(or nearest office)

Please send me a copy of the new Link-Belt Roller Chain Drive Data Book No. 1257.

Firm.....

Address.....

City..... *State*.....

LINK-BELT COMPANY

Leading Manufacturers of Positive Power Transmitting Equipment

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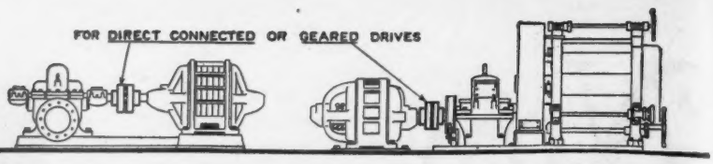
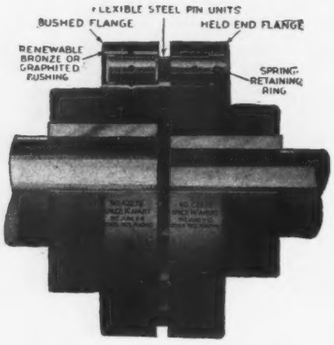
LINK-BELT

FRANCKE
FLEXIBLE COUPLINGS
FOR MOTORS, TURBINES, ENGINES



All metal :-: Durable :-: Flexible in all directions :-: Spring cushion for load shocks and vibrations :-: Endwise displacement :-: Easy means to lineup shafts :-: Reversible :-: Noiseless :-: No backlash :-: No movement or wear on flanges :-: Interchangeable parts :-: Easily assembled :-: A size for any load, speed or power :-: Low cost and maintenance

Francke couplings are an enduring part of the connected machines



More important than the first cost — *and many use FRANCKES because they cost so little*—is the fact that provision has been made for quickly, easily and cheaply renewing parts without even moving the flanges.

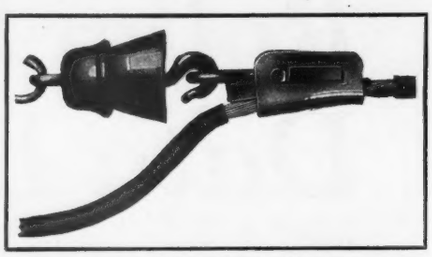
The steel flexible pin units are locked in place by a spring retaining ring and these pin units are free to move endwise within bushings in the other flange. *No movement on either flange.*

Almost as simple as a rigid coupling but effectively handles accidental shaft misalignments and cushions load shocks.

SMITH & SERRELL, 26 Washington Place, Newark, New Jersey

FOR DEADENDING and TURNING HEAVY CORNERS
USE KEARNEY ECONOMY CABLE CLAMPS

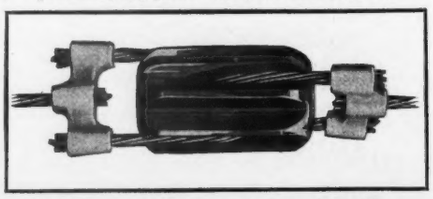
THE use of Kearney Economy Cable Clamps eliminates the necessity of cutting or tapping cables. This clamp, manufactured in three sizes, can be used to deadend or turn cable on heavy corners. The cable is clamped through a driven wedge and the tighter the cable is pulled, the tighter the wedge takes hold and prevents any possibility of the cable slipping. These clamps can be used in close spacing where the nearness of one cable or wire conductor to another does not allow the use of a clamp that is wide and bulky. The parts of the clamp need no adjustment as they are solid and fit in place with ease. Write for Bulletin 328.



Note how securely the wedge of a Kearney Economy Cable Clamp holds the cable under tension, preventing any possibility of the cable slipping.

Distribute Strain on Insulators

The use of Kearney "No-Serve" Yokes eliminates excessive strain insulator breakage. These yokes, manufactured in several sizes, distribute the strain over the entire assembly and eliminate spot loading on the insulator. The castings of these yokes are made of pre-heated certified malleable iron, guaranteed against breakage. Write for your copy of Bulletin 329 today.



Two three-cone yokes, on a single insulator, illustrated above, make a neat, positive compact assembly.

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BEING ADOPTED NATIONALLY AS STANDARD EQUIPMENT

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THE LATEST *Magnetic* SWITCH

KYR Distinctive Features

Control—Lever type combined with relay reset...2 or 3 wire...local or remote. Manual or automatic or combined manual and automatic.

Thermal overload relay. Adjustable from 80% to 120% load.

Interchangeable thermal elements.

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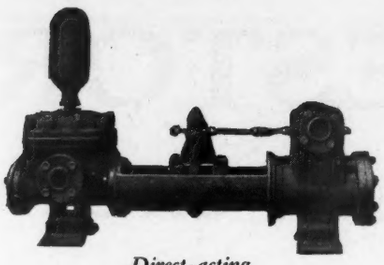
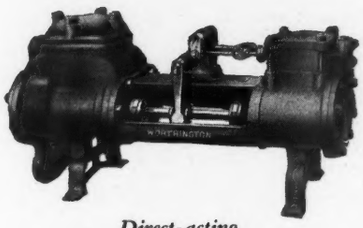
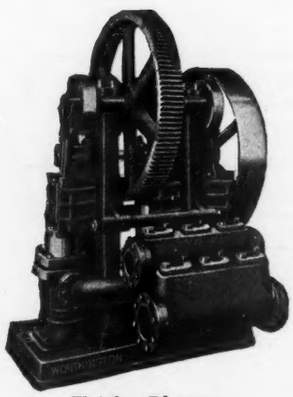


Direct-acting Simplex Steam Pump

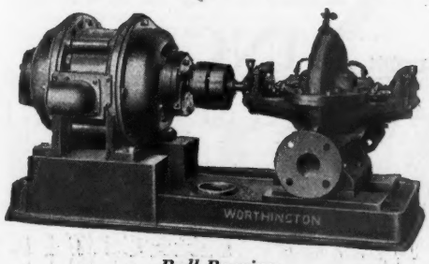


Direct-acting Duplex Steam Pump

Duplex Piston Power Pump



Triplex Plunger Power Pump



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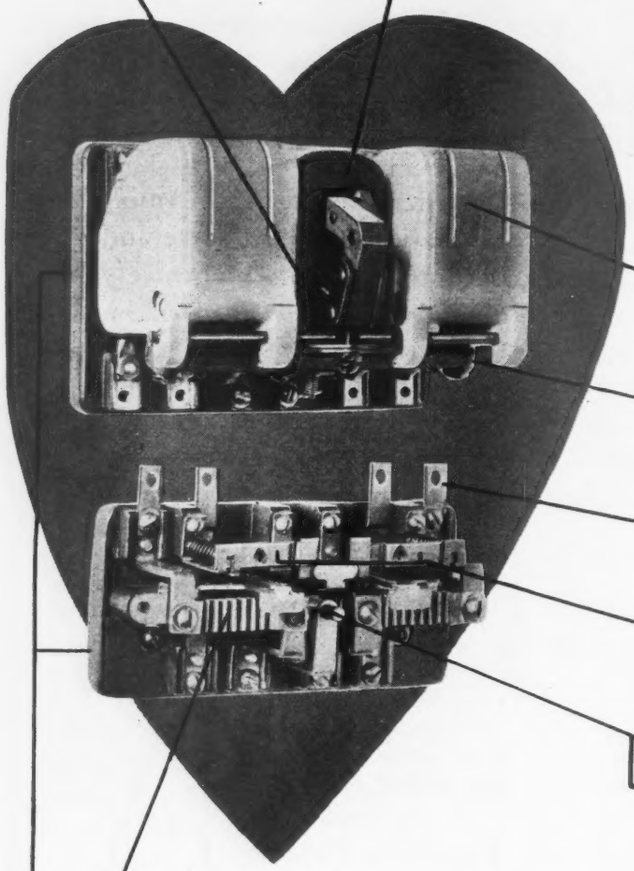
6013 ACLINESTOR

The heart of the control circuit


Coil held rigidly in place.
Coil requires small consumption of power.
Cold molded asbestos arc shield.
Insulated bar for supporting contacts.
All parts cadmium plated.
Push button contacts.
Reset button straight through the box—no flexible leads.
Resistive conductor heater.
Separate cold molded bases.

For the thousands of "starts" and "stops" of your motors, you demand and insist upon absolute dependability. Why, then, not insist upon an across the line starter which you know will guarantee you uninterrupted production? The heart of your circuits will not fail you if you insist on the 6013 Aclinestor. Let us tell you about it.

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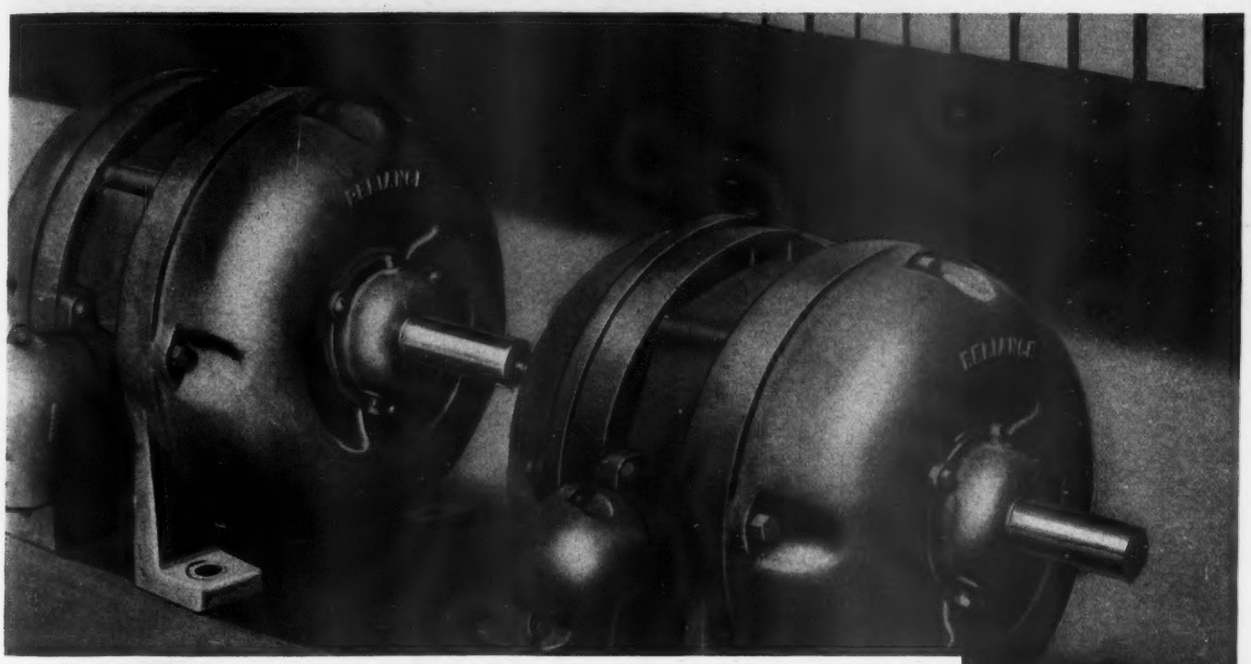
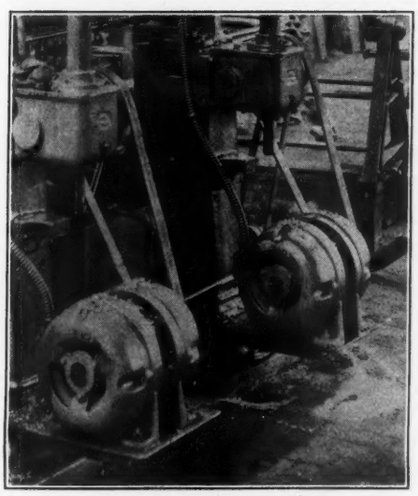


GET STILL BETTER SERVICE *from your motors*



It is in locations like this that you can expect better service by using enclosed fan-cooled Reliance Motors. These motors are on drill presses and exposed to flying chips and splashing coolant.

Reliance offers an improved method of protection which insures longer life with less maintenance.

You likely have open-type induction motors which are showing excellent records for steady operation even under unfavorable conditions. In such cases, however, you are probably taking long chances and incurring extra expense for inspection and maintenance which can be avoided.

The Reliance method of enclosing with fan-cooling makes it possible to give complete protection to all vital parts without complications which mean excessive cost. Common trouble makers such as iron dust, chips, oil and moisture cannot get in to clog air gaps and damage the windings. You can mount the motors any place and be sure that they will stay clean inside.

Learn the full value of this protection by getting one of these enclosed Reliance Motors to work on a tough job in your plant.

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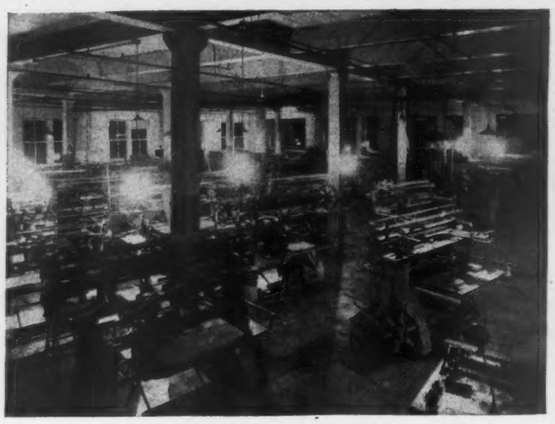
RELIANCE A-C D-C MOTORS
with Ball Bearings



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Poor Lighting Costs MORE Than Silvray Illumination!

Indirected light for industry

High-speed production under poor lighting—an unsafe and costly condition. The remarkable improvement in plant lighting available thru the use of Silvray Industrial Units is graphically shown above. Silvray means illumination without glare, with dangerous shadows eliminated, with every foot of floor space evenly and efficiently lighted—and it costs less than ordinary lighting.

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NOTE:

THE SILVRAY PROCESS APPLIED TO YOUR OWN LAMPS DOES NOT INTERFERE WITH YOUR LAMP CONTRACT.

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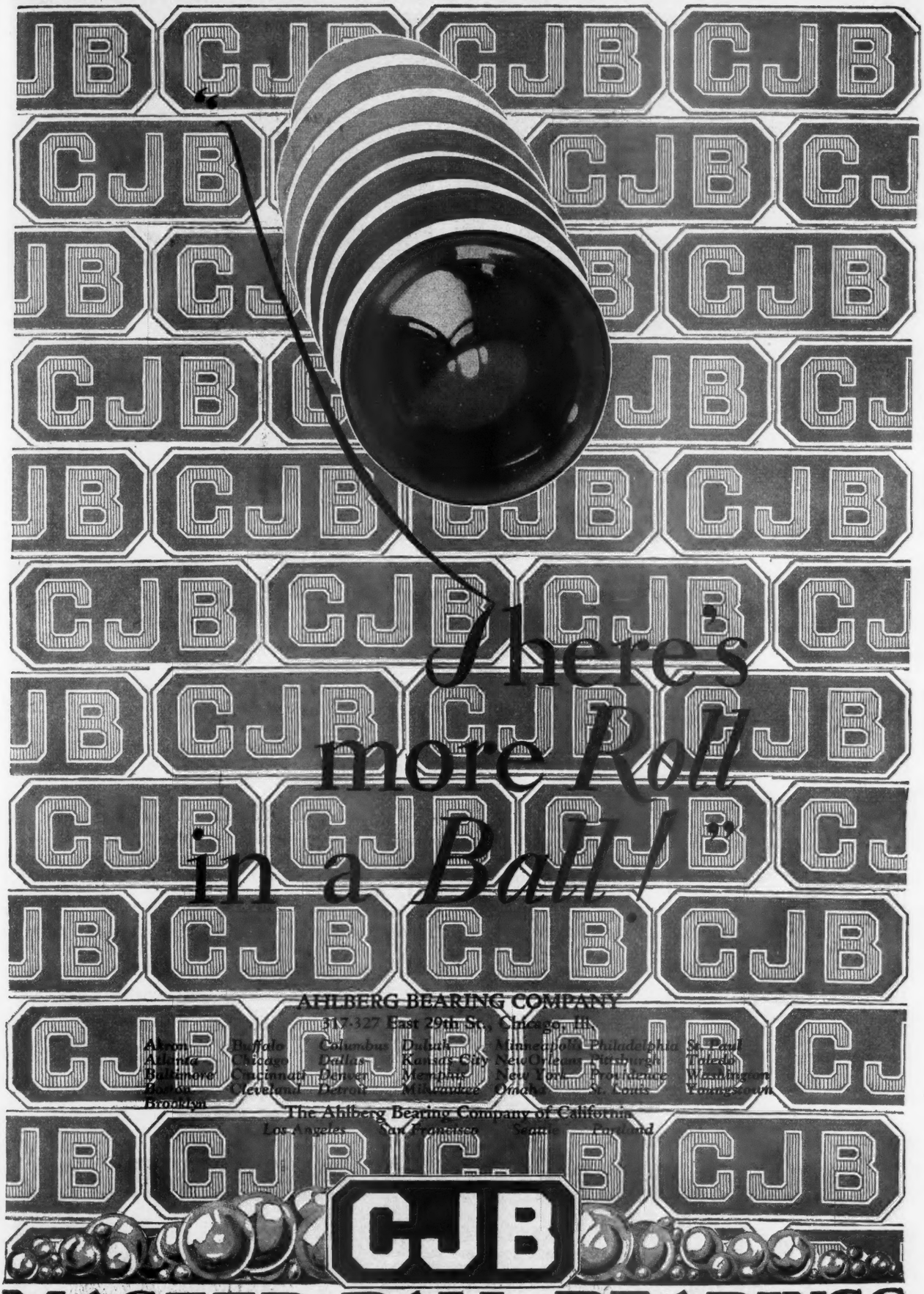
SILVRAY INDUSTRIAL LIGHTING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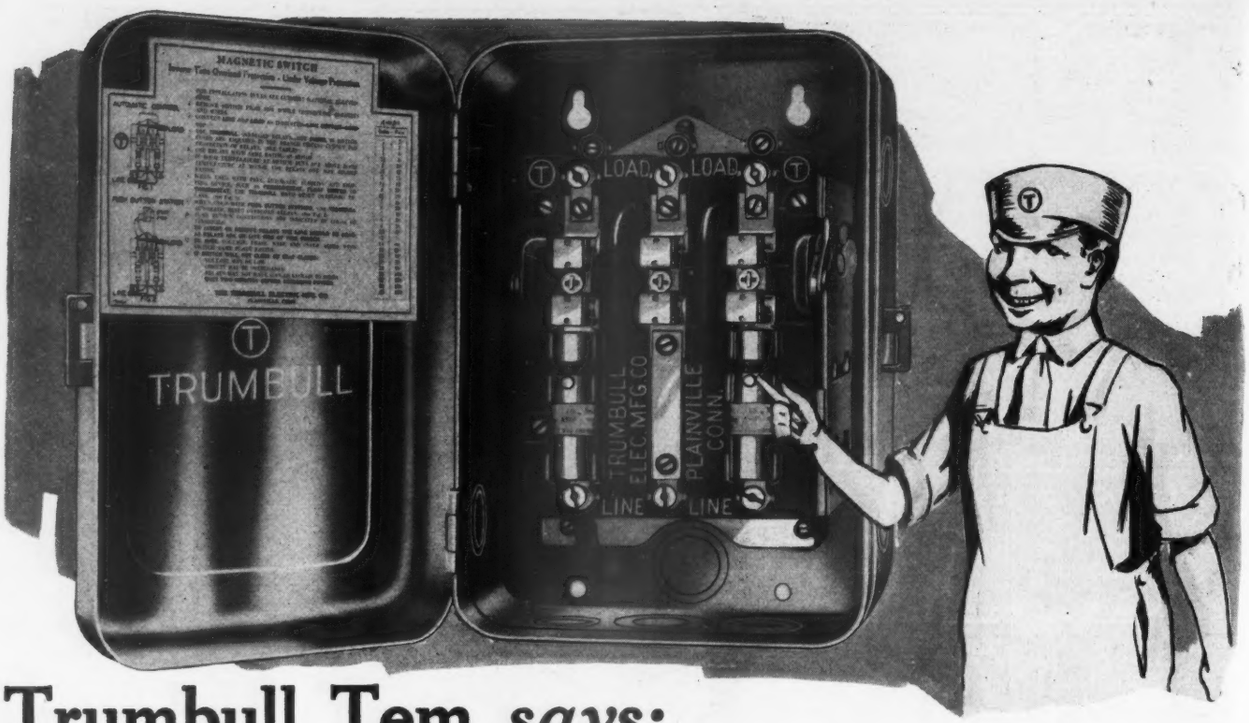
MASTER BALL BEARINGS



Trumbull Tem *says:*

"Look at that Relay!"

SIMULTANEOUS Double Break Action as in "Circle T" Switches has a tremendous advantage in reducing arcing. The contacts have a wiping movement under spring pressure of about 1/8-in. in closing. The switch has no flexible connections.

RATINGS

Volts	Single Phase	Polyphase
115	3 HP.	5 HP.
230	5 HP.	10 HP.
460	7½ HP.	15 HP.
575	7½ HP.	15 HP.

These switches have been subjected to tests in which they have broken the stalled rotor current of motors far in excess of their H.P. rating.

"CIRCLE T"
MAGNETIC SWITCHES

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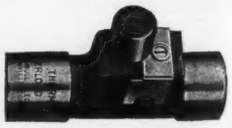
The photo of the "Cirle T" Magnetic Switch shows it equipped with automatic reset relays which make it unnecessary for the operator to go to the switch to reset the relay after tripping on an overload. To restart the motor it is only necessary to push the start button after allowing about one minute for the relay to cool.

In case the switch is used on automatic control, it is then advisable to use the hand reset relay, which, in case of overload, will hold the motor circuit open till the overload condition is corrected and the relay manually reset.

You ought to know all about this remarkable switch with its SIMULTANEOUS Double Break Action. Full details gladly sent.



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520 N. Michigan Ave. Chicago, Ill.

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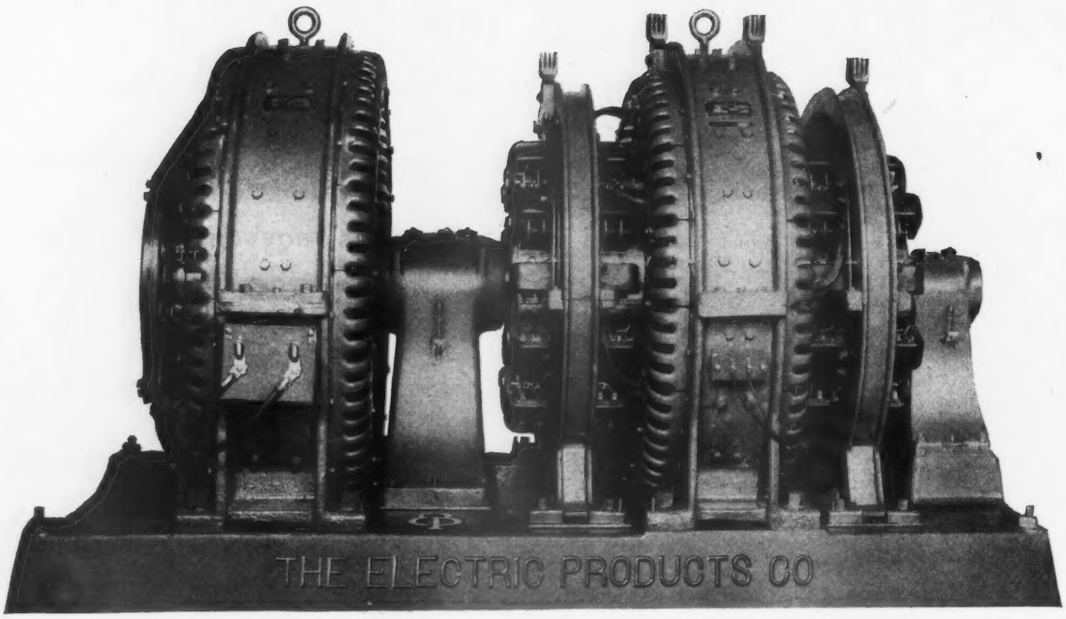

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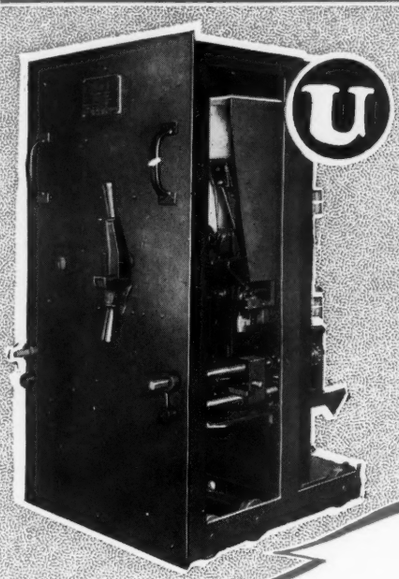

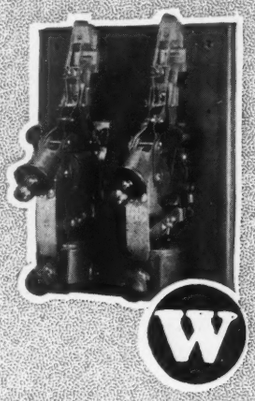

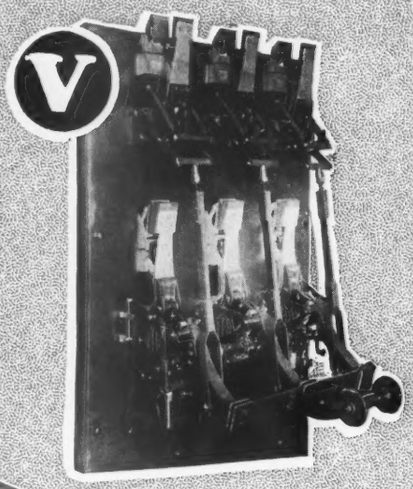

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